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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

MAY 26.

North of England Institute of Mining and Mechanical Engineers:—Ordinary meeting at Newcastle-on-Tyne. "The Use of Carbon Monoxide Masks in Mines," Paper by Richard White.

JUNE 2-9.

Exhibition of Quarrying, Plant and Machinery, Building Materials, etc., at Blackpool.

JUNE 9.

Institute of British Foundrymen.

West Riding of Yorkshire Branch:—Summer outing.

JUNE 12-15.

Annual meeting and conference at the Association Hall, London Road, Leicester.

The Use and Abuse of "Service."

There is no more abused term in industry to-day than "service." Service is an essential in any business operation, but owing to its modern exaggerated significance it is creating a state of mental atrophy amongst the buyers' engineers. Some little time ago an apparatus of the simplest possible character, selling at something less than £15, was furnished to a Scottish foundry by a London firm. Some slight difficulty was experienced in putting it into operation, and so without any further ado a letter was sent asking for the services of an engineer to demonstrate its application. As the fare to Scotland plus reasonable expenses approximates two-thirds of the selling price, the buyer must either have imagined that enormous profits were being made or more probably that the service department of any establishment possesses no limit in its endeavours to give satisfaction. As "service" is nowadays expected from every manufacturing and merchanting concern, we consider it essential that it should be clearly defined. Primarily, it should be recognised that there is the limiting factor of purchase price, which in the case cited should indicate to the buyer initially that "service" beyond correspondence could scarcely be expected. But for important purchases "service" should be limited to a guarantee of satisfaction in the stipulated performance of the product. Any extension of this must either make for lack of initiative by the consumer's staff or imposition of an inordinately high selling price to cover the cost of continuous attendance by the seller's technical representatives.

The modern businessman is insistent on the desirability of a standard price for a standard article. He is aware that included therein is a cover for starting up or other service, but if through lack of initiative this amount becomes seriously exceeded, then other customers must go short, or in its worst aspect an unnecessary loss is incurred which impoverishes the general buying capacity of the country. We want our readers to regard "service" as a luxury, which should not be abused, on the double ground of killing internal initiative and the impoverishment of honest suppliers—a factor tending to increase the cost of future machines or supplies.

The Value of Conferences.

Although critics are heard to deplore the growing tendency at the present day to confer on any and every subject, very few people would seriously question the utility of conferences and conventions. But they might be less clear as to the exact nature of that utility. The papers presented at such meetings as the forthcoming I.B.F. convention at Leicester can, after all, be read in print quite easily afterwards, it is pointed out, and often at greater leisure and in more concentrated fashion. The visits arranged can very frequently be made privately at far more convenient times. Conferences represent a waste of several days, which can only be justified if regarded more or less in the light of a holiday. And so on.

The mistake that all these critics make is to underestimate the personal factor and the value of contacts. A paper that is so many pages of rather fatiguing print broken up by abstruse diagrams becomes a reality if the author of it has been met, talked to, argued with, for a couple of days or so. A visit to a works, a dock, an exhibition, becomes doubly valuable if paid in company with other equally interested people who can bring to bear upon it the point of view of their peculiar and individual experience.

Most important of all is the mere fact of meeting people—people engaged in the same work under the same conditions, people engaged in the same work under different conditions, people engaged in different work under the same conditions. Are their problems the same as ours, or do they manage to avoid those particular pitfalls? How do they solve them when they do arise? Have they suffered from certain particularly bitter experiences of our own, and if not have they been more skilful or merely more fortunate? Then again, what happens abroad? Are the minds of founders in France, Belgium, Germany, etc., occupied with the same matters as ours, or are we isolated sufferers? And, above all, what kind of men are they, these workers in our own field?

A conference is announced and the programme circulated, and it is probable that the character and calibre of the papers and discussions arranged is largely the factor that induces busy people to attend or not. The conference takes place, and attention shifts to the visits, the size of the casting that such and such a firm is about to pour, the method on which such and such another organises its foundry. The conference ends, and personalities emerge. Named processes assume a new importance when the name belongs to a personal friend, products and businesses that have once been associated with a real man or group of men gain a fresh importance, and instead of being an isolated and perpetually bothered unit, the "conferencier," as they call him across the Channel, carries away with him a sense of fellowship and co-operation that can be obtained in no other way whatever. This fellowship and co-operation is one of the finest tonics for industry, and when industry can afford to dispense with tonics it will be time for the men in industry to dispense with conferences.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

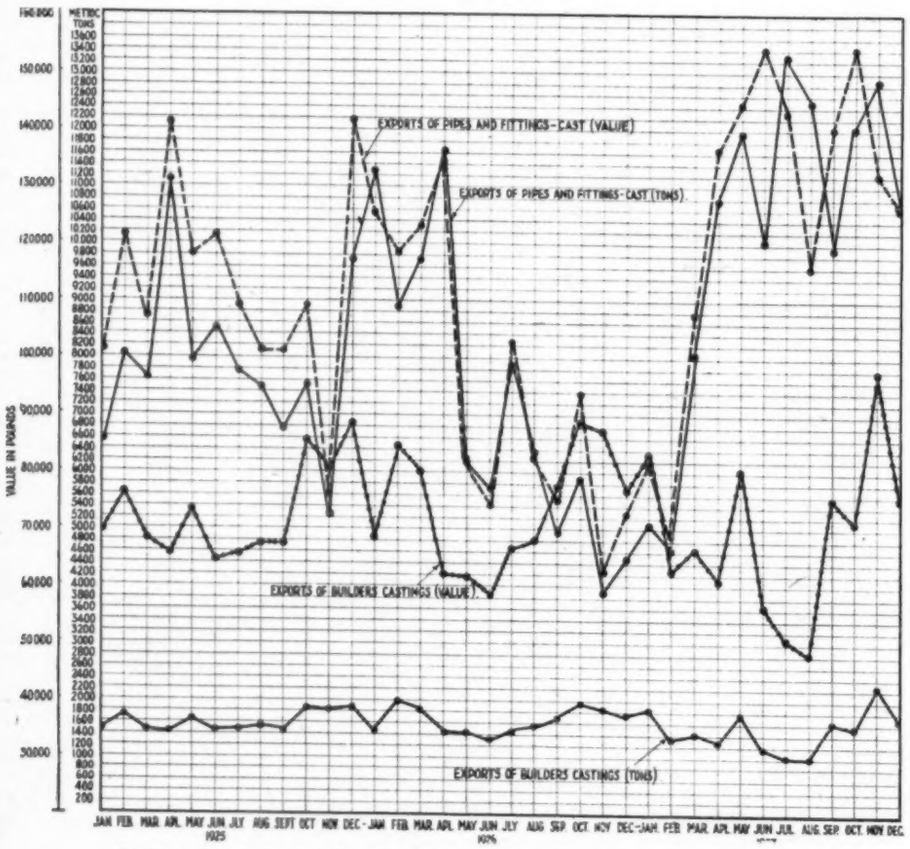
Railway Passenger-Carriage Charges.

To the Editor of The Foundry Trade Journal.

Sir,—The desire expressed by railway companies, to the Commission now sitting, to extend their facilities for the convenience of the trading community, prompts us to call attention to a useful privilege which formerly existed, but has now been withdrawn.

At one time railway companies accepted traffic by passenger train, carriage forward, but to-day all passenger carriage charges must be paid by sender. The sender is therefore compelled to *estimate* the cost of passenger carriage, and as it is not always possible to estimate it accurately, discrepancies occur. Railway companies' accounts are not rendered, as a general rule, until a week or so after the despatch of the goods and if it is found that the carriage charges have been underestimated, the customer is annoyed by receiving a request for payment of the balance of carriage. If, on the other hand, the customer discovers that the carriage has been over-estimated by the sender, he naturally feels that he has not been treated fairly. All this causes considerable friction, which would be eliminated if railway companies would revert to the old method of collecting passenger carriage charges on delivery, in the same way as they now collect carriage charges from consignees in respect of traffic sent by goods train.—Yours, etc.,

Barimar, Ltd.
G. E. Frost, Deputy Manager.
14-18, Lamb's Conduit Street, Theobald's Road, London, W.C.1.
May 19, 1928.


METRIC TONS
VALUE IN POUNDS
EXPORTS OF PIPES AND FITTINGS-CAST (VALUE)
EXPORTS OF PIPES AND FITTINGS-CAST (TONS)
EXPORTS OF BUILDERS CASTINGS (VALUE)
EXPORTS OF BUILDERS CASTINGS (TONS)
JAN FEB MAR APL MAY JUN JLY AUG SEPT OCT NOV DEC-JAN FEB MAR APL MAY JUN JLY AUG SEP OCT NOV DEC-JAN. FEB MAR APL MAY JUN JUL AUG SEP OCT NOV DEC.
1925
1926

British Exports of Builders' Castings and Cast-Iron Pipe in 1925-6-7.

British Ceylonese, Limited, are erecting a new foundry at Spondon, near Derby, to cater for their own requirements.

Foundry Wages.

The National Light Castings Associations and the Trade Unions with which they deal are meeting to-day in Glasgow to consider proposals for a revision in wages. The employers are asking for a reduction of 10s. per week on the rates for piece-workers with a corresponding reduction for time rates. The movement suggested is to be extended to youths and labourers, 2s. 6d. per week reduction being suggested for the latter.

New "Perlit" German Licensees.

The following is a complete list of the German firms who have recently taken up a licence to manufacture Lanz perlit iron:—(1) Bayrisches Huttenarar, Munich; (2) A. Borsig, G.m.b.H., Berlin-Tegel; (3) Gute Hoffnungshutte, Oberhausen; (4) Haniel & Lueg, Dusseldorf; (5) Maschinenfabrik Augsburg-Nurnberg, Nurnberg; (6) Maschinenfabrik - Esslingen, Esslingen; (7) Maschinenfabrik Renk, Augsburg; (8) Mitteldeutsche Stahlwerke Lauchhammer; (9) Vereinigte Stahlwerke, Gelsenkirchen, and (10) Schwabisches Huttenwerk, Wasseralfingen.

British Industries Fair.

The Preliminary Prospectus of the Birmingham Section of the British Industries Fair is now available. Following custom, it is to be held at Castle Bromwich, from February 18 to March 1. Mr. R. C. Rodgers has been elected president, Mr. Walter Barrow vice-president, and Mr. C. E. Greener the honorary treasurer. The exhibition is under the management of Mr. Charles Stanley, 95, New Street, Birmingham.

Random Shots.

No one who heard the latest recipient of the Bessemer Medal when he spoke at the recent dinner of the Iron and Steel Institute can have failed to be impressed by the personality of that large-hearted American, Charles M. Schwab. It was amusing to see his evident relief when he had overcome the difficulties of "Mr. President, Your Excellency, My Lords, Ladies, and Gentlemen": it seems not unlikely that his more usual mode of address on such occasions is the less formidable "Now, Boys —" His remarks were peppered with stories at frequent intervals—yet when it comes to retailing them I confess myself in a quandary—they were principally of the type that lose their savour when detached from their context, so that though they were highly entertaining as part of Mr. Schwab's speech, they would risk failure at "Marksman's" hands.

* * *

As a matter of fact Mr. Schwab's speech was exceedingly interesting, and still more interesting was the emphatic welcome it received from what might fairly be called a representative steel audience. It was marked by an invincible optimism that was in no sense the outcome of facile ignorance, but rather of long experience of conditions in a country where the annual steel output has increased something like tenfold in a short space of time. He added some definite suggestions that, were he a Steel Mussolini, he would like to see applied to the British steel trade. The chief of these were that works should combine into groups and that the home industry should be protected . . . . . Altogether an interesting personality and a significant occasion.

* * *

As for the question of stories that lose their point if detached from their context, here is one as a test case. "Marksman" had been somewhat desultorily following a correspondence in a daily paper as to the odd misunderstandings of words and phrases that arise when uneducated ears meet unfamiliar expressions. This story was given in illustration, and struck "Marksman" as extremely amusing. He has since repeated it once or twice and scarcely raised a laugh. Do *you* think it funny? An old villager, hearing his daughter singing the old Christmas carol, "Noel," stopped her peremptorily. She asked what was wrong. "Well," said he, "it's downright impious. You're a-singin' 'No 'ell, no 'ell,' and there *is* a 'ell, so jest you stop it!"

* * *

And talking of impiety, "Marksman" has with his own ears heard a cook complain that she was in need of "desecrated coconut," while I believe "consecrated essence of beef" has also been heard of.

* * *

The Poets on Ironfounding.

They wept like anything to see
Such quantities of sand:
"If this were only cleared away,"
They said, "It would be grand!"

(Lewis Carroll).

* * *

Some Sayings We Haven't Heard This Week.

The Foundry Manager: "I always believe in trying every new method as soon as I hear of it."

The Foreman: "I consider my men to be unequalled in intelligence and energy."

The Apprentice: "This is such a delightful shop to work in—the manager is indeed a gentleman."

The Works Chemist: "It is so encouraging to have such importance and confidence attached to everything one does."

Marksman.

Cupola Refractories.

At a meeting of the Lancashire Branch of the I.B.F., held on April 17 at the Manchester College of Technology, Mr. E. Longden presiding, Mr. W. Holland read a Paper entitled "Refractories for the Cupola."

Refractory materials are divided into three distinct classes, namely, acid, basic and neutral. In considering the subject as applicable to cupolas, the two latter classes may be omitted, although certain experiments are at present being made with the neutral class.

In these days of keen competition the foundryman must have the best value for his money. He must not be misled by materials which are cheap in initial cost but expensive in the long run. It is unfair to compare two materials on their initial cost per ton without taking into careful consideration their *practical worth* over a period. The only way in which to judge them is to compare costs *per ton of metal melted* over a period of several months, at the same time bearing in mind other important factors, such as quality of the metal, amount of fuel and flux charges, quantity and quality of slag produced, labour costs, etc.

The selection of the right material is certainly not an easy matter, for the founder cannot spend all his time testing this brick or that patching. Where, however, the manufacturer has made a claim for his product, and is willing to fulfil that claim in practice, it is sometimes policy to accept his proposition if he is not going to interfere with the daily routine in any way.

There are to-day many brands of firebrick and ganister as well as special plastic refractories from which the founder may choose. The cheapest is generally proved the dearest in the long run, since excessive repairs become necessary and cause hindrance to production. For example, a cupola might be lined with one set of firebricks for, say, £10, but if that lining caused endless trouble, necessitated extensive repairs and had to be taken out at the end of six months, would it be a cheaper proposition than another set of firebricks initially costing, say, £20, but lasting double the time and giving good service?

Going a step farther, the £20 firebrick lining is not necessarily the most economical because it is 10 or 20 per cent. cheaper in first cost than a monolithic lining standing longer and needing less repair after each cast.

Naturally the same thing must apply to the patching material. Too frequently a daubing material may be turned down as too costly, simply because its price per ton is greater than that of the material at present in use. The man responsible for the upkeep of the cupola lining will best realise the value of the various materials.

Sometimes analytical and heat tests are made in the laboratory, and the material either adopted or rejected on the result. The laboratory test is certainly advisable, but does it conclusively prove the behaviour of the particular material when it is used on a practical scale and under the vastly different conditions ruling in the cupola?

It is not proposed to enter on the individual merits of the many refractories at the disposal of the ironfounder, but a brief outline of the chief requirements of a satisfactory material may be of interest. Principally they are: (1) Resistance to intense and sudden changes of heat; (2) resistance to the corrosion caused by chemically active reagents, etc., and (3) resistance to the abrasive action of the cupola charges.

In the cupola high temperatures are reached by the continuous blast of air from the blower or fan. Frequently this has no controlling gear, and a temperature in excess of actual requirements is produced, all to the detriment of the lining. In many cupolas the upkeep cost of the lining could be considerably reduced by proper attention to the tuyere arrangement and blast pressure. This Paper is not intended to deal with the faulty construction of many cupolas, but such effect do these things have upon the refractory that enlargement is definitely germaine.

Only quite recently the author has had to do with two cupolas, both of the same melting capacity but at different works. The one is working on a 4½ in. lining only, and the erosion after a blow of 20 tons is not often more than 1½ in. in the worst place. In the other cupola, which works on a 9 in. lining, the erosion after a similar cast is anything between 4½ and 6 in. The difference in results has been traced to the tuyere arrangement and control of blast pressure in the latter case.

Spalling is a not infrequent trouble, and is generally due to sudden changes of temperature as well as the incorrect use of the daubing mixture. The amount of destruction depends, of course, upon the texture of the refractory. Due to the impinging effect of the cold blast upon the hottest part of the lining, spalling is usually severest around the tuyeres.

If the daubing material be applied too wet and no provision made for the escape of the steam which becomes generated under heat, the patch will be forced away and the lining left fully exposed to the damaging effects of corrosion and abrasion. This trouble can, however, be easily prevented by knowledge of the daubing material, and care taken to see that it is correctly used.

Corrosion of the cupola lining may be very severe, and is largely due to the chemical reaction set up between the acid nature of the refractory and the basic nature of the lime slag. There are also other fluxing agents present in the cupola which readily attack and destroy the lining. Porous refractories offer greater scope than do dense ones for the penetration of the corroding agent. The joints of a brick-lined cupola are the first to be attacked, and this is obviously one of the main reasons for the growing popularity of rammed linings.

Great care needs to be exercised both in the quality and the quantity of the flux used, and sometimes better judgment in the selection of the fuel would well repay the user. Cheap cokes containing high percentages of ash and sulphur are not a business proposition if the effect upon the cupola lining as well as upon melting results be carefully considered.

The damage caused by the falling charges of iron, scrap, limestone, and coke needs controlling. These batter against the lining and where the daubing is newly applied, bring it away in large pieces. Iron bricks are frequently placed opposite the charge hole to take the brunt of the impact. To charge the cupola by hand may seem out of date from an engineering point of view, but it is certainly more helpful to the lining than is the mechanical charger.

Rammed Linings.

The method appears to have gained greater popularity during the past few years, no doubt due to the efforts of manufacturers to produce the ideal refractory for the purpose. In certain districts materials like Gornal sand have been used for cupola ramming for many years, but such a lining invariably lasts more than a week and then needs renewal. Refractories of a sandy nature have not been found suitable. The surface may glaze at a high temperature, but behind the glaze the material loses its nature and powders away.

The best refractory for the purpose would seem to be one which becomes vitrified into one solid mass under the heat of the furnace, and takes on a protective glaze. Such material will contain sufficient bond for ramming, and needs to be carefully prepared and graded with a view to resisting as well as is possible the destructive actions already outlined.

Skilled bricklayers are certainly not required to instal a rammed lining, but great care needs to be given to the installation, otherwise the most satisfactory refractory may prove no better than bricks. Each manufacturer has his own particular way of tackling the job, due, of course, to his intimate knowledge of the product. Some of them offer the services of a supervisor to ensure the user getting complete satisfaction.

One of the most apparent advantages of the monolithic lining is the elimination of brick joints, thereby minimising the field of attack for the corrosive agents. Another point is that a rammed lining provides better insulation, and the heat of the cupola is better conserved, thus showing an economy in fuel and melting a hotter metal.

It remains to be seen whether the rammed lining will eventually supplant the brick for cupolas, but as with any new device or method which once gains a firm foothold on the market, it should at least be given a trial to prove whether it is of any value to the user.

Discussion.

The discussion was opened by Mr. A. Phillips, who said every foundryman had his troubles with cupolas and cupola linings, and in his opinion the application of a refractory material for lining cupolas was more important than its initial composition. For patching a cupola the cupola man wanted something which he could handle readily and which was easy to apply. Many of the refractories on the market at the present time required very careful manipulation when daubing the cupola, if the best results were to be obtained, and the average cupola man was apt to apply the material with the moisture content too high, because it was much easier to use in that state. This is an important point in cupola refractories, and patching material when applied to a cupola should be of a consistency that when squeezed in the hand it will form a ball. If it is used too damp it will crack when dried and fall away into large patches, giving difficulties in cupola operation. Regarding rammed-up lining there is no doubt about it you eliminate one great difficulty, "slag penetration," because you do not have the number of joints that are exposed with a brick lining. The joints of brick linings are their weakest points, although cupolas lined with correctly-fired and uniformly-shaped bricks have given highly satisfactory results. Generally, if any coating can be obtained that can be easily applied to a cupola face that will improve the life of the lining it will be very helpful to every foundryman.

Mr. J. Masters said in regard to this matter of refractories there was room for improvement in foundry practice. The question of the contraction or expansion of cupola linings was of great importance, and no doubt Mr. Holland could enlarge upon it. He did not agree with Mr. Holland that hand-charging was better than mechanical-charging. Most of those present had had the pleasure of visiting an establishment in the Midlands where entirely mechanical-charging was used for some of the biggest cupolas in this country. Damage to the cupola from charging mechanically was negligible. It was simply a matter of the apparatus being arranged properly, whilst the limestone ratios were all worked out on a scientific basis. A little cupola-charging arrangement had been recently described in The Foundry Trade Journal, and he had seen that apparatus in use. It did not allow the charge to bump on the cupola lining half as much as when the charging was by hand. The latter was a very tedious and dangerous job, especially when there was a back draught. In his opinion hand-charging ought to be abolished. The little apparatus he had mentioned was quite efficient and could be developed to suit any size of cupola. Any material desired could be used, if it was applied properly. To his mind more damage was done to cupola linings by erratic methods of charging than from any other cause. With regard to blast pressure, some people used 7 ozs. and expected to get decent results. They let it impinge on about three localities in the furnace instead of trying to equalise it in the melting zone. There was as much difference in the quality of bricks as in ganister, and probably the cheapest material to use was the best, even if most expensive in the first instance.

Mr. J. Jackson stated a case where rammed linings had been recently adopted, and experience to date justified the continued use of them. One instance was a cupola which was rammed ten months ago and had been working since on two blows daily. The patching material now required was 9 to 11 cwt. per day. Previous to having the rammed lining, the other conditions being the same, the ganister required for daily patching was anything from 15 to 19 cwt. Further, the metal was now certainly cleaner. That was probably

due to there being less falling off of patching material on the rammed cupola, and consequently the slag could function better.

Previous experience had been that at the commencement of the blow they had 5 to 15 cwt. of semi-dead "slow" metal, heavy in kish; now, immediately the metal was melted, which was in 8 to 10 minutes from the blast being put on, they had a good hot fluid and clean metal, fit to cast practically any job in the shop. He had not yet fully satisfied himself as to the whole reason for this improvement, though it was remarkable how clean hot and free iron they had had since the introduction of rammed linings.

He had found that a cupola could be rammed-lined at half the cost of the same cupola when brick-lined; and whereas on an average a brick-lined cupola required re-bricking after eight months' continuous work, rammed linings were in good condition after the same amount of work.

Many firms had a practice of fixing iron bricks just around the charging holes, the idea being to protect the wall against abrasion from the charging of pig, scrap, etc. Either with brick linings or rammed, hand-charged or bucket-charged cupolas, his experience was that however well interlocked they were, they gradually grew out, worked loose and loosened the adjoining lining. From his experience he would advise, at least for rammed linings, that iron bricks around the charging hole be dispensed with.

Mr. C. H. Connell said his experience led him to prefer a brick lining to a rammed lining as being infinitely superior. Not long ago, after a rammed lining had been used on one occasion, it had to be pulled down because it fell away in bits.

Mr. Holland said no doubt one of the greatest troubles was caused by excessive moisture being added to the daubing materials. Steam was generated and no provision was made for its escape; therefore patches were forced off and the lining was exposed long before the blow started. With regard to rammed linings, it was necessary the material should be of the correct consistency. Care must be exercised when the rammed lining was being installed; otherwise it would not prove its value. No difficulty would be experienced with expansion and contraction if the material was of suitable texture and capable of resisting sudden changes of temperature. Iron bricks had been found very suitable on some of the larger cupolas, but again that depended on the conditions under which the cupola was working. Mr. Masters also raised the question of hand charging versus mechanical charging, and the battering against the lining. That was a matter in which a great deal depended on the design of the charging apparatus. Mr. Jackson stated that he found he got hot fluid metal right from the commencement of the blow. Probably the reason was that the material, being highly refractory, the coke was doing the work of melting the iron instead of melting the patching. The rammed cupola provided better insulation and the heat was conserved.

A vote of thanks to Mr. Holland was passed unanimously.

A Unique Survival.

By H. Littlehales.

Any object of metal is interesting and if it be of a curious form the interest is often greater. If in the days when Henry VIII was king we had looked through the window of our local ironmonger's shop we should have seen in many ways the same things we see in it to-day. But had we looked closer we should have noticed one or more long-handled iron implements which at each end spread out into a flat surface or blade. These implements were for the purpose of cooking thin wafers made of flour and water.

The ironmonger has for centuries sold these irons, most, if not all, of which bore on one of the two flat surfaces a design which might either be of a religious or secular character. If religious, the design would represent the crucifixion, a sacred monogram or some such emblem. If the cakes were to be for domestic consumption the irons would bear often the arms of the owner of the house.

It is a somewhat singular fact that of the thousands of irons formerly in use to cook the communion wafers in or for the church, only one example survives in England, that used in medieval days in the church of Feckenham, in Worcestershire. This survivor, of which a photograph is given below, shows us the design to be imprinted by the blade upon the surface of the Communion wafer. It represents the Crucifixion and the Sacred Heart surrounded by a very beautiful circle of rays and flames. The size of this particular pair of irons is shown by the foot-rule placed beside them. This shows us that these irons had handles of a considerable length, clearly that they might enable the bakers to stand well away from the fire. The window of the medieval ironmonger's shop was, there is good reason to believe, of no very great extent and one or more

A Ceremonial Wafering Iron.

of these irons would, if placed in the window, take up much of the room available for display. So far as the present writer is aware these irons sold by ironmongers and used to cook wafers are not mentioned in medieval ironmongers' accounts or their bills, nor do we find them mentioned in the accounts of medieval churchwardens.

These irons have been called "wafering irons," but, so far as the present writer is aware, there is no authority for such a name. Probably a better name would be "waferer's irons." Murray, who in his great English Dictionary, gives practically every word in common use in medieval times makes no mention of such a name. The great dictionary, however, gives references of early date to the "wafer": to the people by whom they were made, "pybakers and waferers," and to the place in the medieval house where they were made, "the wafery."

It will be noticed, probably with some surprise, that though the ecclesiastical wafer was invariably of a circular form, the blades of the Feckenham example are pear shaped! From the design, however, it is fairly clear that that part of the design enclosed in the circle was the only part indispensably necessary for the production of the wafer.

In the Iron Room of the British Museum is another waferer's iron. This, however, is of Italian workmanship. It is of the 15th century and much like the Feckenham iron, but in the Museum example the blades are of oval, not pear-shaped, form. For our photograph we are indebted to the courtesy of the Vicar of Feckenham.

Development of Standardisation and Simplification.

The President of the Board of Trade (Sir Philip Cunliffe-Lister) presided at a recent meeting held to consider means for the further development of standardisation and simplification.

The President recalled the resolution passed at the Imperial Conference in 1926 in favour of the further development of standardisation in the widest sense of the term and of Imperial co-operation for that purpose. Inquiries had since been proceeding with a view to giving effect to the resolution in this country. The movement had received a further impetus from the visit of Mr. Julins, the Chairman of the Australian Council for Scientific and Industrial Research and of the Commonwealth Engineering Standards' Association, who had explained the steps taken to establish an Australian Association of Simplified Practice, and had urged the desirability of inter-Imperial consultation. It was felt that before this country was in a position to participate effectively in an inter-Imperial movement, some further progress must be made hre, and the President had called the present influential meeting in order to ascertain the views of some of the representative associations in British industry on the question of initiating a forward movement here.

With regard to standardisation proper it was, of course, most desirable that the valuable work conducted by the British Engineering Standards' Association should be continued and developed by that body. Attention had, however, been drawn—largely by the work done in the United States of America and Germany—to the great economies which might be effected in many trades by what was known as simplification or the elimination of unnecessary types of articles, to the consequent advantage of producers, distributors and users. This was work which must in detail be performed by those actually concerned in the particular industry in question, whether as manufacturers, dealers or users. At the same time, the experience of other countries confirmed the view that some central organisation was necessary to bring before particular industries the advantages of simplification and to assist those concerned in coming together for practical discussions.

He wished, therefore, to suggest that the meeting should consider whether it would be desirable to establish a central committee which would undertake this work. He did not think it could be done effectively by a Government department; what was needed was a representative body in close touch with the various branches of industry.

The subsequent discussion showed a general agreement as to the importance of developing standardisation and simplification further than the movement had yet gone in this country, and as to the necessity of having some central organisation of the kind suggested. The meeting requested that a representative of the Board of Trad should act as chairman of the proposed body. It was accordingly decided to set up a Committee under the chairmanship of Mr. Herbert Williams, M.P., consisting in the first instance of the representatives of the Associations enumerated above, together with representatives of Government departments concerned.

Catalogue Received.

Nickel Chrome Pig-Iron.—The Bethlehem Steel Company, of Bethlehem, Pa., U.S.A., are publishing a series of pamphlets to be known as the "Magari News." The first issue is devoted to a description of the iron, which, as is well known, is a natural nickel chromium pig-iron containing small quantities of titanium and vanadium. We consider that a mistake has been committed in not outlining the full composition initially. Certainly the silicon, manganese, sulphur, and phosphorus contents are detailed, and an interesting comment is made that it is undesirable to add more nickel to change the existing natural ratio of this element to the chromium. We look forward with interest to receiving future issues.

Second Report on the Heterogeneity of Steel Ingots.*

By a Committee of the Iron and Steel Institute.

(*Abridged.*)

(*Continued from page 356.*)

III.—Certain Features of Steel Manufacture which may Influence Heterogeneity.

A study of the heterogeneity of steel ingots would not be complete without due consideration being given to three important factors, each of which depends essentially upon the process of manufacture employed—namely, the presence in the ingot, and the origin of: (1) Oxides and silicates; (2) sulphur, phosphorus, and extraneous elements; and (3) gases.

Oxides and silicates, which occur as non-metallic inclusions, apart from causing obvious defects when badly segregated, even when dispersed as small inclusions, lead, in exaggerated cases, to the production, as a result of hot-work, of "woody" fractures.

As regards the presence of sulphur, structurally free sulphides of manganese or of manganese and iron (or possibly of even more complex composition) have the same general effect as other non-metallic matter in destroying the continuity of the metallic aggregate, particularly on account of their facility for segregation. Phosphorus also, owing to the readiness with which it segregates, should be as low as economic and process considerations permit. The effects of the presence of other extraneous elements such as arsenic and copper need further investigation.

With regard to the presence and influence of the gases remaining in solution in the solidified steel, it must be confessed that little exact knowledge is available, and that much work requires to be done.

A more complete understanding of the physical chemistry of steel-making would make possible a better control of these factors. In each type of process the temperature of the raw material is raised until the conditions are such that a liquid metal is in contact, and reacting, with a superimposed layer of liquid slag. The variable composition of the metal and of the slag, the variation in temperature, and also in the composition and volume of the gases reacting upon the metal charge during melting, and afterwards upon the upper surface of the molten slag, all introduce complications which render the study of the nature of the reactions extremely difficult.

Much of the large tonnage of steel made is tapped with the slag relatively high in oxide of iron, and the manganese and silicon, alloyed with iron, are added in the solid form to the liquid steel as it issues into the ladle. Assuming, therefore, that oxide of iron is present in the liquid steel, the reaction with the manganese and silicon presumably produces insoluble oxides dispersed through the liquid in the ladle in an extremely fine state of division. The present view is that the silicate of manganese produced from the union of these two oxides constitutes the most serious form of non-metallic inclusion. The incompleteness of knowledge on this subject, however, is illustrated by the work of Stead, Dickenson, and others, which disclosed that some of the silicates isolated from acid open-hearth steel did not consist entirely of manganous silicate, but were probably complex silicates of manganese, iron and other elements. The precise nature of the reaction between the added deoxidisers and the oxygen which is held to be present in the liquid steel is therefore not finally established.

Clearly, however, if the steel is "finished" in this manner, the amount of the silicate present in the finished steel will be dependent upon the composition of the slag, since the oxygen content of the steel depends upon the equilibrium ratio between the oxygen in the slag and the oxygen in the metal. These comments apply to both the acid and to the basic processes.

The operation of the acid and basic Bessemer processes involves analogous considerations, but it can hardly be doubted that the effect of overblowing is to increase the amount of silicate inclusions.

As regards the electric process, it can be stated that although its physical chemistry is not fully investigated, better facilities exist for deoxidation than in any of the other processes discussed, and that this does, in fact, lead to an improvement in practice. This is due to the fact that in the basic-lined electric furnace a completely "reducing" slag can be produced during the later stages of the process, so creating conditions such that the oxides of iron, manganese, and chromium in the slag are reduced to very low values, and the deoxidation of the metallic bath accomplished.

The question of the gas content of the steel, and its influence upon the steel during freezing, is fundamentally important. It must be assumed that the molten metal has absorbed gas during the process, which tends towards an equilibrium value for the particular conditions existing in the furnace, but it is not established that the gases given off from the steel represent the composition of the gases which were in solution. It may, however, be stated that evidence tends to show that the gases contained in blowholes, and also those evolved from solid steel when heated *in vacuo*, consist of hydrogen, carbon monoxide, and nitrogen. The presence of sufficient silicon and manganese in the steel at the moment of freezing decreases the amount of gases evolved during the critical stage of freezing, thus preventing the formation of blowholes. Aluminium has a similar effect, and produces alumina, which may remain in the steel as non-metallic inclusions. As will be shown in Section V, the evolution of gases during the freezing range appears to have a material effect upon the distribution of the segregating constituents within the solid steel.

Temperature Control and Measurement. — The temperatures existing in the furnace are fundamentally important in their effect upon the reactions, and therefore upon those factors which have already been considered in this Section. In practice, they are dealt with on more or less empirical lines. The casting temperature is, however, so important in the present connection as to be one of the determining factors, both of the distribution of segregation in the ingot and of its crystalline structure.

In the present Report the temperatures recorded for streams in the open—all determined by the optical pyrometer (generally of the Cambridge type)—include a uniform correction of 125 deg. C. To readings taken inside the furnace, where black body conditions are approximated to, no correction has been applied. In the absence of a thoroughly satisfactory basis of correction the Committee considered that the course adopted was the best, and this statement of the correction employed will enable those interested who use a different method to compare their own observations with the figures given.

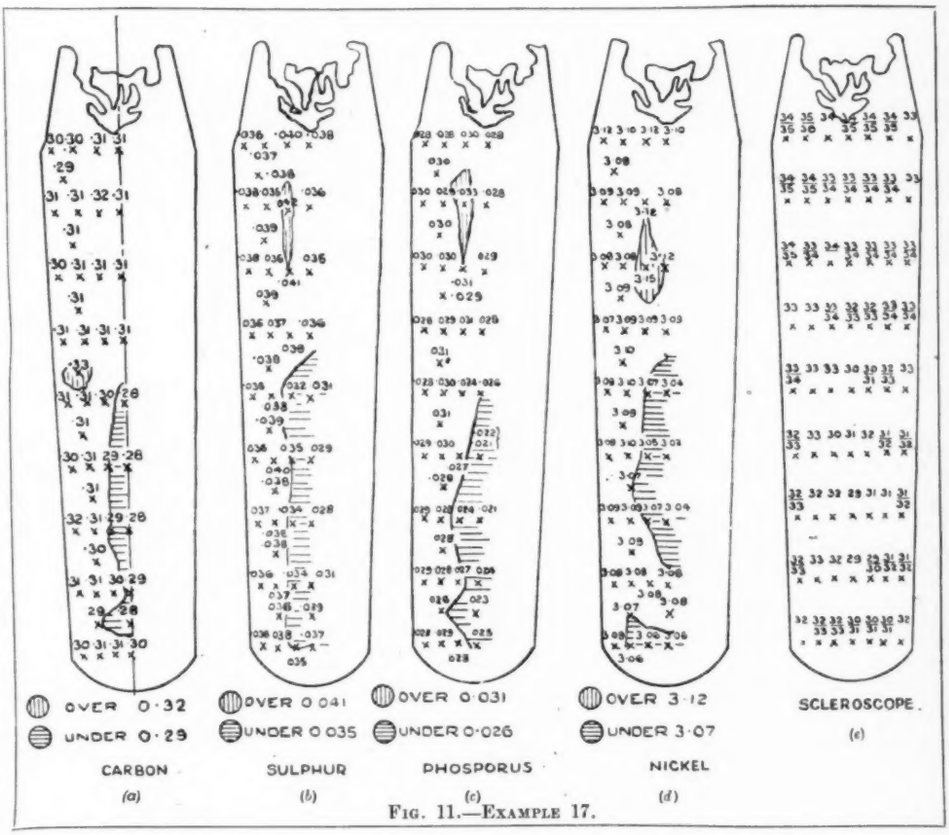


FIG. 11.—EXAMPLE 17.

Until the pyrometry of high temperatures under practical conditions, such as exist in steelworks, is more developed, the effect of temperature in the problems under consideration cannot be stated in a sufficiently quantitative way. Fortunately, from the point of view of actual steel manufacture, the best melters are so skilful in judging, not only the temperature throughout the process, but also the finishing temperature, that a much greater regularity of practice is attained than would otherwise be possible. The physical characteristics and appearance of the slag provide the melter with a very good guide to the conditions existing, including the temperature.

[A bibliography of the temperature measurement of molten steel is given in the Report as an Appendix to this Section.]

Casting Speed.—A factor of great importance in its effect upon the characteristics of an ingot, but which is more or less influenced by the casting temperature of the steel, is the speed of teeming. There is clearly a best speed of teeming for

* A Paper read before the May meeting of the Iron and Steel Institute.

a given temperature. If very hot steel is poured very quickly, the internal stresses produced during freezing and subsequent cooling will tend to produce cracks in the ingot. If the steel is not hot enough and the speed of teeming slow, "cold lapping" results, and oxide formed upon the rising surface of the liquid steel in the mould tends to be entrapped in the ingot. The best speed of teeming is difficult to determine, since it will be influenced by the size of the ingot and, to some extent, by the character of the steel. Practical experience invariably leads to a standard method in each works, and it is by the comparison of the effects produced by the conditions existing in various works that valuable data can be derived.

[The Committee include in this Section some information relative to the ingots presented as examples in the First Report.]

TABLE II.—*Details of Alloy Steel Ingots Examined.*

Example.	Description of ingot.	Weight.	Size.	Kind of steel.	Returned typical analyses. Per cent.							Mould used.
					C.	Mn.	Si.	S.	P.	Ni.	Cr.	
		Tons. Cwts.										
17	Ordinary square chill ingot. Cast through a runner box	0 15	Top, 12¾ in. sq. Bottom, 10¾ in. sq. Length in chill, 3 ft. 6½ in.	Acid O.-H. 3 per cent. Ni	0.30 0.31	0.63	0.23	0.042	0.035	3.11	—	*A*
18	Ditto	2 17	Top, 19¾ in. sq. Bottom, 16¾ in. sq. Length in chill, 4 ft. 8½ in.	Acid O.-H. 3 per cent. Ni	0.30 0.31	0.63	0.23	0.042	0.035	3.11	—	*F*
19	Ordinary square chill ingot	2 4	Top, 18 in. sq. Bottom, 14 in. sq. Length in chill, 4 ft. 8 in.	Electric. 4 per cent. Ni-Cr	0.29	0.42	0.27	0.016	0.015	4.38	1.41	*D*
20	Ditto	2 4	Top, 18 in. sq. Bottom, 14 in. sq. Length in chill, 4 ft. 8 in.	Electric. 4 per cent. Ni-Cr	0.29	0.42	0.27	0.016	0.015	4.38	1.41	*D*
21	Ordinary rectangular chill ingot.	49 0	Top, 70 in. × 43 in. Bottom, 70 in. × 31 in. Length in chill, 100 in.	Acid Siemens O.-H. Ni-Cr	0.395 0.405	0.41	0.155	0.032	0.027	3.31	1.67	—
22	Ordinary round chill ingot	50 0	Top, 52½ in. diam. Bottom, 46½ in. Length, 164 in.	Acid-Siemens O.H.	0.405	0.76	0.140	0.034	0.032	0.38	—	*Q*
23		119 10	Top, 75 in. across flats. Bottom, 67 in. Length, 180 in.	Acid Siemens O.-H. Ni-Cr-Mo	0.345	0.54	0.157	0.035	0.028	2.48	0.68	*R*

Example No. 22 had also 0.05 per cent. of Cu, and Example No. 23 had 0.632 of Mo.

IV.—Nickel, Nickel-Chromium and Nickel-Chromium-Molybdenum Ingots.

In this Section the data derived from various representative ingots are given. The method of investigation is identical with that employed for the ingots described in the First Report, so that direct comparison can be made, and the influence of the recorded data concerning mass, analysis, etc., on the characteristics of the ingots considered. Particulars of the ingots studied will be found in Table II. It will be seen that ingots of this class of steel varying in weight from 15 cwts. to 119 tons have been examined. The example numbers given to the ingots follow on from those given to the ingots in the First Report.

Examples 17 and 18 were cast from the same acid open-hearth heat of nickel steel, and therefore, apart from the usual features, a direct study of the effect of mass upon heterogeneity may be made. Examples 19 and 20 were cast in duplicate moulds from the same electric-furnace heat of nickel-chromium steel; the second ingot was cast at a lower temperature, but at a much greater speed than the first, thus enabling the influence of the modified condition of casting to be studied. These four ingots represent modern practice in the production of such alloy steels.

Example 21 is a nickel-chromium steel ingot cast in a rectangular mould. Example 22 is a "carbon" steel ingot containing a little nickel and also a small percentage of copper, the distribution of both of which elements has been studied. Example 23, which is a large nickel-chromium-molybdenum ingot, has been examined with a view to learning the effect of very large mass on the distribution of the elements present, particularly as regards the molybdenum content.

Examples 17 and 18; Nickel-Steel Ingots.—These two ingots were cast mainly to provide information as to whether the element nickel segregates, and, if so, to what extent; also, if possible, to determine whether it influences the segregation of carbon, sulphur, and phosphorus. Further, by casting the ingots of two different sizes and from the same heat of steel, the endeavour was made to obtain information on the influence of the size of ingot upon the segregation by more direct comparison than was possible from the ingots of the First Report. The comparison was rendered still more exact by casting the smaller (11-in.) ingot immediately after the larger (18-in.). They were the last two ingots cast from the heat. The steel was made in the acid open-hearth furnace; the total weight of the heat was 30 tons, and it was poured from the furnace at a temperature of 1,601 to 1,637 deg. C., the bulk coming out at 1,619 deg. C. After casting the bulk of the heat into ingots at a temperature of 1,532 to 1,521 deg. C., the 18-in. ingot (57 cwts.) was cast through a runner box. The temperature of the stream above the runner box was 1,498 deg., and below it, 1,475 deg. C. The rate of pouring through a 1½-in. nozzle was 0.325 ton per minute. Immediately following, the 11-in. ingot (15 cwts.) was cast, also through a runner box, at the rate of 0.63 ton per minute, the temperature of the stream being 1,475 deg. C.

The ingots were sectioned and examined in a manner similar to that adopted for the ingots in the First Report. To bring out in a simple way the character of the segregation in each case in its broad aspect, the zones of highest and lowest percentage, as indicated by the analytical figures, were marked off as shown in the diagrams, by contour lines (see Figs. 11 and 12, *a* to *f*).

Comparisons of the segregated zones for the 57-cwt. and 15-cwt. ingots show at once a distinctly higher degree of segregation for each of the elements in the former case. Dealing only with the useable portion of the ingot—that is, below the refractory head—the limits shown by the figures for the different elements are as in Table III.

While, therefore, as shown by the mapped-out areas, there is clearly a more uneven distribution of the different elements in the larger ingot, there are the same extremes of composition shown by the test samples in both cases, except for sulphur. As the figures show, there is a slight but definite segregation of the nickel, following the same general mode of distribution as the other segregat-

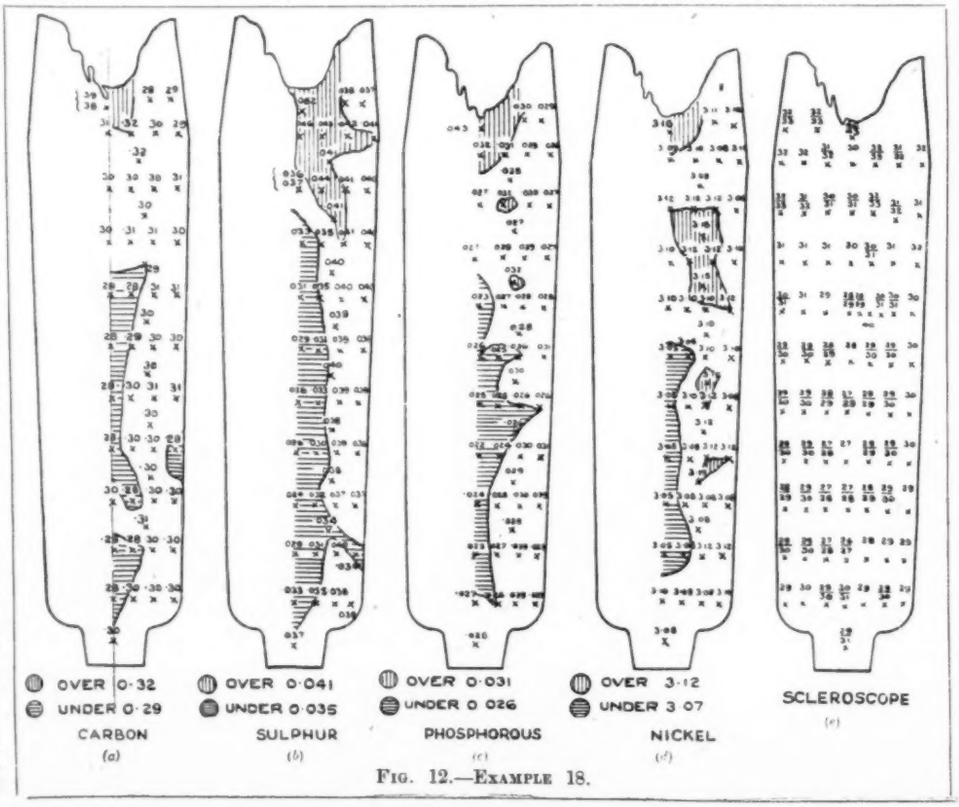


FIG. 12.—EXAMPLE 18.

ing elements, carbon, sulphur, and phosphorus. This is specially significant because of the question of the chemical relations of nickel with the other elements present. Its degree of segregation is, in fact, comparable with that found for manganese in the carbon-steel ingots of the First Report. While, however, manganese combines with carbon and with sulphur, nickel in steel, as far as is known at present, does not combine to any appreciable extent with these other elements, but simply dissolves in the iron. Manganese may therefore be expected to take part in the segregation of carbon and sulphur, but not the nickel.

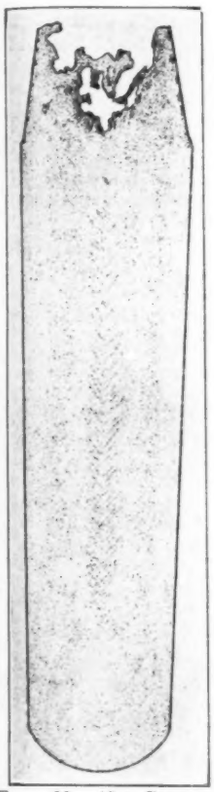


FIG. 11 (*f*).—SULPHUR PRINT. EXAMPLE 17.

FIG. 12 (*f*).—SULPHUR PRINT. EXAMPLE 18.

TABLE III.—*Analytical Comparison of Examples* 17 *and* 18.

Element.	Example 17. 11-in. ingot.		Example 18. 18-in. ingot.	
	Highest. Per cent.	Lowest. Per cent.	Highest. Per cent.	Lowest. Per cent.
Carbon ..	0.33	0.28	0.32	0.28
Sulphur ..	0.042	0.028	0.049	0.024
Phosphorus	0.033	0.021	0.032	0.022
Nickel ..	3.15	3.02	3.16	3.05

The fact of the segregation of nickel, therefore, seems to give support to those theories based on the equilibrium diagram and selective freezing, rather than to those which postulate a floating upwards of segregates. Taking the elements as a whole, both effects may be in operation, but it seems apparent that the effects resulting from the characteristics of the equilibrium diagram have their share. On the other hand, these results may be an indication that nickel does, contrary to the present ideas, associate chemically with one or other of the elements mentioned.

The remarks made above would seem to imply that nickel would have little effect upon the degree of segregation of the other elements as compared with what happens in the absence of nickel. For definite evidence upon this point, ingots of similar size and composition, and otherwise similar in all respects, but without nickel content, are really necessary. Some sort of approximate comparison is, however, possible between the 57-cwt. ingot and the 55-cwt. ingot, Example 4 of the First Report (Fig. 13, *a* to *e*). The corresponding compositions are as in Table IV.

TABLE V.—*Nickel-Steel and Carbon-Steel Ingots.*

Element.	Nickel-steel ingot.		Carbon-steel ingot.	
	Highest. Per cent.	Lowest. Per cent.	Highest. Per cent.	Lowest. Per cent.
Carbon ..	0.32	0.28	0.43	0.32
Sulphur ..	0.049	0.024	0.047	0.032
Phosphorus	0.032	0.022	0.055	0.039
Nickel ..	3.16	3.05	Nil	Nil

The ingots are both of acid Siemens steel, square in the case of the nickel steel, but somewhat rectangular and shorter and heavier in section for the carbon steel. The latter was also cast in a much lighter chill. The casting temperature was, however, similar, namely, 1,480 deg. C. There is also a difference in the plan of exploration of the sections for variations in analysis. These differences are sufficient to prevent any definite conclusions as to the influence of nickel, but it was nevertheless thought interesting, in view of the point of similarity, to make the comparison. The figures obtained in the same way as those above work out as in Table V. On these figures, carbon and phosphorus have segregated less in the ingot of nickel steel, but sulphur has done so to a greater extent.

As a basis of further comparison, areas have been mapped out on the diagrams for the carbon-steel ingot (Fig. 13) in a similar way to those prepared for the nickel-steel ingot (Fig. 12). These show zones of high and low percentage for the various elements, carbon, sulphur, and phosphorus. In view of the differences in average composition of the two ingots shown by Table IV, and for want at present of any more scientific basis of comparison, the limits chosen for these areas have

(*Continued on page* 372.)

TABLE IV.—*Comparison of Nickel-Steel and Carbon-Steel Ingots.*

Ingot.	Weight. Tons.	Cwts.	Analysis. Per cent. C.	Mn.	Si.	S.	P.	Ni.	
Nickel steel ..	2	17	0.305	0.63	0.23	0.042	0.035	3.11	Test ingot
			0.3035	—	—	0.0380	0.0285	3.095	Outer zone of ingot (average)
Carbon steel ..	2	15	0.34	0.72	0.282	0.040	0.043	Nil	Test ingot
			0.370	—	—	0.0385	0.0451	Nil	Outer zone of ingot (average)

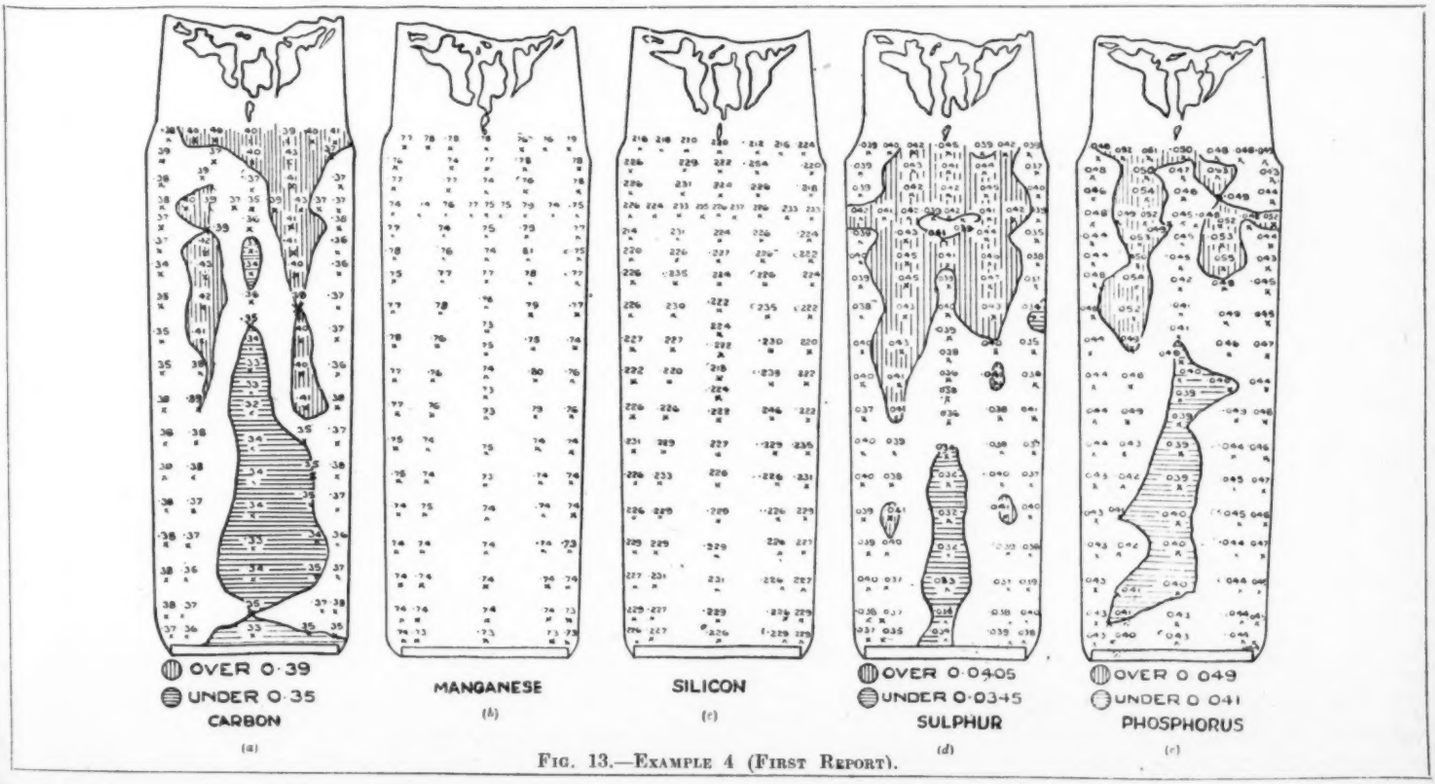


FIG. 13.—EXAMPLE 4 (FIRST REPORT).

Rail Conditions of Carriage.

EFFECT OF RECENT CHANGES.

By J. W. Parker, A.M.Inst.T.

The fact that every consignment of goods sent by rail involves a legal contract is seldom appreciated until some unusual occurrence such as a claim causes one or other of the interested parties to inquire into the position. He will then be confronted by a formidable list of regulations, all of which go to make up the contract between the sender and the railway. These rules have been assembled from various sources; the common law supplied some direct, others are the result of general legislation or special Acts of Parliament, whilst a number have come into force as the result of accumulated experience in the transport of goods. In addition, the rules up to January of this year were not necessarily common to all lines. A consideration of these features brings one to the conclusion that conditions of carriage operative under such circumstances were not really satisfactory. Consequently it is not surprising to find that the wholesale reorganisation of railway law and practice embodied in the Railways Act of 1921 should be made the occasion for bringing up to date the conditions of carriage. By this Act the railways were required to draw up new rules for submission to the Rates Tribunal. This body had power to hear the objections and suggestions of interested traders and to make such alterations as they thought fit, after which the new or standard terms, in the words of the Act, were "deemed to be reasonable." In times past a very large number of legal actions were fought on the subject of what were reasonable conditions, but henceforth there will be no need for proceedings of this kind.

No Consignment Form Necessary.

The revised conditions came into force on January 1, and really constitute a code of terms to which any rail user can refer and ascertain his position in respect of delay, loss, damage, rights as to payment, lien, stoppage in transit and various other points which arise from time to time. One outstanding result of these terms is that for goods carried at company's risk, they apply without any contract in writing. The orthodox form of consignment note need no longer be used, nor is it necessary to sign such a declaration, as the new conditions apply automatically. Thus if one were disposed to consign goods on the back of an envelope, such a form would hold good in law. This change, however, is not an advantage in every case, as under the old order those firms who used their own form of consignment note were able to avoid the restrictive effect of some of the old rules, and this was often a valuable consideration to them. To-day this benefit is lost, and all firms are upon an equal footing in this respect.

There are different sets of regulations for goods sent at company's risk, owner's risk, damageable articles not properly protected by packing, coal, etc., but as it is impossible to touch upon all the separate sets, present remarks will be confined to company's risk terms.

The first regulation deals with the railways' right to have a full description of the goods. Their powers in this respect were originally laid down by the Railway Clauses Act of 1845, and were more clearly defined by the Railways Act, 1921. As a result the companies are entitled to have full details of weight, packing, quantity, nature, etc., of the goods offered for conveyance. The same rule places the railways under a new obligation in so far as they must, if desired, sign a receipt prepared by the trader as acknowledgment of the goods having come into their possession, but this form cannot be taken as evidence of the quantity or condition of the goods.

The requirements as to the labelling of wagons loaded in private sidings are carefully set out in the second condition, which lays down that each truck must have a label on each side bearing particulars of the destination, nature of goods, weight and owner and number of the truck.

The third condition is of vital importance as it defines the railway's transit liability and is in itself an admirable exposition of the law, since it gives a full list of the excepted perils. It is also noteworthy on account of the straightforward manner in which liability is admitted. To say that the companies admit responsibility in all cases unless they can prove the loss, damage, or misdelivery is due to an excepted risk, is really a great gain to the trader, as it means the railways have not taken advantage of their common carriers' right to throw the onus of proof upon the claimant. As given in the regulations, the excepted risks are Act of God, act of war or King's enemies, arrest or restraint of princes and rulers or seizure under legal process, orders or restrictions imposed by governments, act or omission or fraud of the trader, inherent liability to wastage in bulk or weight, latent defect, inherent defect or natural deterioration, and a casualty. Except for the last named, the perils mentioned do not require extensive consideration as they are all recognised at common law, but a casualty is a fresh departure, and was conceded by the traders as compensation for the railways having taken upon themselves more than their common law responsibility respecting the other risks. A casualty, it should be noted, includes both a fire and an explosion.

Delay is a matter which often causes trouble, particularly as the old regulation was not very satisfactory to the trader because it required him in theory if not in practice to prove negligence in order to substantiate any claim for detention. Under the revised rule, things are reversed as the railways take upon themselves the burden of disproving negligence.

Period for Claims Revised.

In most cases, the standard conditions were discussed by both railways and traders before being submitted to the Tribunal, an arrangement which made it possible to bring before the Court agreed regulations. An arrangement of this kind indicates the harmonious relations existing between railways and their customers, whilst it makes both parties almost equally responsible for the revised rules. Unanimity was not possible in every instance; on the contrary, the regulation dealing with the time limit for the lodging of claims for damage revealed such a divergence of opinion as to render compromise impossible. By the old regulation, a claim for damage, etc., had to be made within three days of the termination of transit, a state of affairs which operated unfairly towards the trader as it prevented many otherwise sound demands from being made. At various times, the question of extending this interval had been raised, but the railways had always objected. When the revised rules were being considered, traders made a determined stand, but the companies argued that a condition which had been in force for more than 60 years must be reasonable to have survived, and also that it was necessary to receive early intimation of damage, etc., to enable investigation to be made whilst the occurrence was fresh in mind. The Tribunal's way out of the difficulty was to maintain the three-day interval as the period in which to give notice, but seven days were allowed in which to make the claim. In special circumstances an indefinite period might be conceded so that in certain cases it is correct to say the time limit scarcely exists. In the case of claims for non-delivery, the previous rule made it necessary for claims to be lodged within 14 days of date of despatch. This, in its way, was just as unsatisfactory to the trader as the three-day period, and consequently an extra fortnight was conceded, making 28 days in all.

Prepayment of Carriage Charges.

At common law, the railways always had the right to insist upon their carriage charges being prepaid, a matter which is not disturbed by the new terms. For goods which are accepted "carriage forward" their position is very appreciably strengthened. Previously they could not detain any other goods to enforce payment upon a consignment already delivered, in other words, they had only a particular lien, but the fresh conditions give them a general lien under which they may hold all or any goods until their legitimate charges demands are satisfied. This is one of the more obscure points with which it is desirable to be fully conversant, particularly during a period of industrial depression like the present.

Another important point is that which imposes a warranty upon the sender of goods. By the revised terms, all articles are warranted to be fit for transit or warehousing in the condition in which they are handed to the railways. Although warranties have been customary with some other means of transport for many years past, their introduction to rail transits presents a distinct novelty.

The standard terms and conditions of carriage are not necessarily fixed for all time in their present form, as provision was made in the Railways Act whereby the railways, or an authorised body of traders, might apply to the Tribunal for alterations, modifications, or additions to the existing rates. In such an event, the Tribunal, after hearing all proper parties, have authority to introduce the desired changes. In this manner the terms will be kept in line with the trade developments and changed requirements as and when they occur.

It remains to be recorded that the new terms have been drawn up in a clear manner, commendably free from legal obscurities, and in consequence they are likely to gain more approval from the trader than the lawyer.

Second Report on the Heterogeneity of Steel Ingots.

(*Continued from page* 371.)

been taken as nearly as possible in proportion to those for the nickel-steel ingot, using, as before, the average composition of the outer zones as a basis, on the assumption that they are more directly comparative than the analyses shown by the test ingots.

The segregation of carbon, as shown in this manner, is rather more pronounced in the case of the ingot of plain carbon steel. The average content of sulphur is very similar in the two cases. The mode of distribution is, however, appreciably different, making comparison difficult. In the case of the carbon-steel ingot there is a zone of comparatively low sulphur content, and a large one where the values are high. In the nickel-steel ingot, the reverse is the case.

As regards phosphorus, of which the average content is appreciably greater for the carbon-steel ingot, the degree of segregation in the carbon-steel ingot seems greater on the whole than for the nickel-steel ingot.

Altogether, and bearing in mind the imperfections in these methods of comparison, and the absence of a definite criterion as to degree of segregation, it does not seem safe to say that nickel has any definite influence on the degree of segregation of the elements carbon, sulphur, and phosphorus.

Incidentally, it is interesting to see how these diagrams, whether for carbon, sulphur, phosphorus or nickel, and in either carbon steel or nickel steel, indicate in a fairly consistent way the general mode of the segregation in ingots; there is a comparatively pure zone along the axis and towards the bottom of the ingot, and also a zone of the highest concentrations at the top of the ingot, which sub-divides lower down, so as to occupy a position between the purer axial zone and the outside surface of the ingot.

(*To be continued.*)

British-Norwegian Ferro-Silicon Agreement.—According to a Norwegian paper an agreement has been reached for the delivery of ferro-silicon from the great plants at Björlvefossen, near Bergen, to a British group represented during the negotiations by Messrs. Tennant & Sons' Company, of Oslo. The quantity to be delivered is at present unknown, but the capacity of the Björlvefossen furnaces is estimated at about 25,000 tons of ferro-silicon per annum.

The Causes of Failure of Wrought-Iron Chain and Cable.*

By H. J. Gough, M.B.E., D.Sc., Ph.D., and A. J. Murphy, M.Sc.

(*Continued from page* 353.)

Properties of Various Wrought-Iron Chains drawn from Service of known History.

Attention was then directed to the investigation of the properties of a series of wrought-iron chains drawn from service of known history. An exhaustive series of tests was made on each chain. These included static and impact tests on sample lengths of chain, together with a full series of mechanical tests made on specimens cut from chain links. All these tests were made on chain in three conditions: (1) as received; (2) after prolonged annealing at 650 deg. C.; and (3) after normalising at 1,000 deg. C. It will be sufficient here to refer briefly only to some of the general conclusions arising from the tests.

(i) *Showing that chains which have been periodically annealed are in a very ductile state and free from brittleness when tested in the annealed condition.*

(*a*) *Tests on a* $\frac{3}{4}$*-in. Crane Chain* (Reference Mark CSJ).—This chain had been used for thirteen years on a hydraulic crane and had been proof-tested and annealed six times during that service.

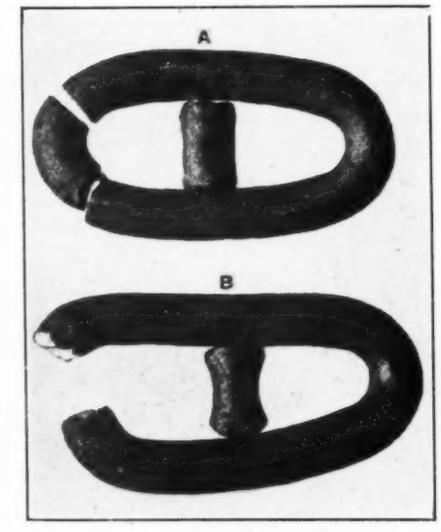


Fig. 15.—Fractured Links.

It arrived in the annealed condition. Thus, should this service (with the loads and shocks associated with crane usage), coupled with periodic annealing, tend to produce a brittle chain, this particular chain should have been an excellent example. The tests made on specimens cut from the links, however, showed that the material was in a condition equal to that of best wrought iron in the annealed state. The static tensile tests made on chain lengths revealed a state of extreme ductility, the breaking loads and energy-absorbed values being comparable with those of new chain. There were, however, many signs that the welds had suffered deterioration during service. Shock tests (impact-tensile) revealed more clearly the defective condition of the welded joints, the energy-absorbed figures being low. In the cases where weld failure did *not* occur, high values of the figures for energy absorbed and elongation to cause fracture were obtained, showing that the wrought iron was in an essentially ductile state.

(*b*) *Tests on a* $1\frac{1}{4}$*-in. Bucket-Lifting Chain* (Reference Mark CEQ).—This chain had been in use on a dredger for thirteen years, during which it had been proved and annealed on six occasions. It had been withdrawn from service owing to its worn condition (most of the links also showed the curious preferential corrosion, taking the form of grooves following the direction of piling, so often observed in old wrought iron). With this chain, exactly similar test data were obtained as with the $\frac{3}{4}$-in crane-chain (CSJ). The material of the chain, judged from tests on small specimens, was in an excellent condition. The static tensile tests and impact tensile tests, also, while revealing a deteriorated condition of the welds, showed that, apart from this deterioration, the material of the chain possessed excellent shock-resisting properties. Fig. 13 shows two typical examples. Both samples were fractured under shock, and parted in the neighbourhood of a welded scarf. The deterioration of the weld in the lower sample had been much more marked than in the other samples, and this was shown in the relative values of the energies absorbed to cause fracture and the total elongations. It is to be noted that the links of both samples were greatly deformed before fracturing.

The general conclusion made from the tests described briefly above is that chains which have been periodically annealed through a long and strenuous service (crane and dredger-bucket lifting services are particularly exacting) are not in a brittle condition when tested in the annealed state. The progressive deterioration of the welded joints is, however, clearly demonstrated; no heat-treatment can, of course, repair this serious defect.

(ii) *Showing that a chain tends to become brittle in service and that annealing, while proving an effective cure, will not prevent the subsequent redevelopment of the brittle condition.*

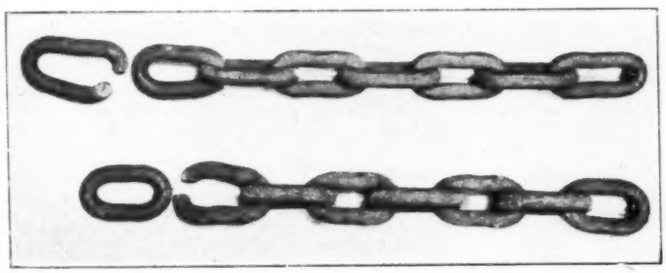


Fig. 13.—Tests on a $1\frac{1}{4}$-in. Bucket-lifting Chain.

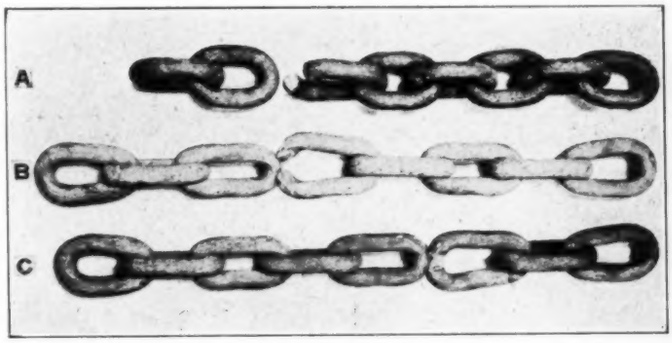


Fig. 14.—Typical Examples after the Shock Test.

Table II.—*Results of Mechanical Tests on Specimens cut from Chain Links (Average Values).*

	Tensile tests.						
	Stresses, tons per sq. in.			Elongation on 1 in. Per cent.	Reduction of area Per cent.	Energy absorbed ft.-lbs. per cub. in.	Type of fracture.
	Limit of proportionality.	Yield point.	Ultimate strength.				
Dredger chain (CER)	11.5	15.0	24.4	28	45	1,250	Fibrous and ductile.
New chain (CES)	12.1	15.6	23.6	33	45	1,280	Fibrous and ductile

Tensile-impact tests (Un-notched specimens).				
	Energy absorbed to fracture, ft.-lbs. per cub. in.	Elongation on 1 in., per cent.	Reduction of area, per cent.	Type of fracture.
Dredger chain	1,580	24	40	Fibrous and ductile.
New chain	1,490	24	47	Fibrous and ductile.

Notched bar and Brinell-hardness tests.		
	Energy absorbed to fracture, ft.-lbs.	Brinell-hardness No.
Dredger chain ..	55 (fibrous fracture)	150
New chain	50 (fibrous fracture)	155

Interesting test data on these points were obtained from a $1\frac{1}{4}$-in. chain rigging (Reference Mark CEN) which had been in service, on a hydraulic crane, for a period of ten years. This chain was proved and annealed three times during the first seven years of its service. When received at the Laboratory it had thus endured a further three years' service without heat-treatment. The usual complete series of tests was made. Those made on small specimens cut from links failed to show that the material had suffered any deterioration in service. Static tensile tests on chain lengths in the "as received" condition, while giving slightly reduced values of the maximum loads, extensions, and energies to cause fracture—indicating the presence of strain-hardening effects—were quite satisfactory in view of the past service and somewhat worn condition of the chain. The efficiencies of the welds, although showing sign of the usual service deterioration, were not unduly low. Annealing or normalising conferred additional ductility. Shock tests on chain samples, however, showed that the chain, as received, was in a brittle state. The energy absorbed to cause fracture was low, and the actual fracture was of a very brittle (crystalline) appearance. Other samples were annealed or normalised with most beneficial results, the energy to cause fracture being between 22 and 30 ft.-tons, as compared with 3 and 7 ft.-tons for the "as received" condition. Annealing gave beneficial results equal to those obtained after normalising. Fig. 14 shows typical examples after the shock test; the samples shown, A, B, and C, being tested in the "as received," annealed, and normalised conditions, respectively.

(iii) *Showing that a chain subjected to service and* not *periodically annealed, may acquire dangerous brittleness, which may be removed by an annealing or normalising treatment.*

* A Paper read before the Institution of Mechanical Engineers.

The most instructive test data obtained in the present investigation, leading finally to the solution of the problem of the brittle failure of chains, were obtained from a 1-in. studded chain (Reference Mark CER). This chain had been in service on an Admiralty dredger for six years, during which period it had been twice cleaned (in a rumbling machine) and tested. It had never been annealed, or otherwise heat-treated. To serve as a basis of comparison, 15 fathoms of *new* 1-in. studded cable (Reference Mark CES) were obtained, and a complete series of tests was made on samples taken from each chain. It is desirable to refer to the results of these tests in some detail. The more important of the results of tests made on small specimens cut from chain links are summarised in Table II.

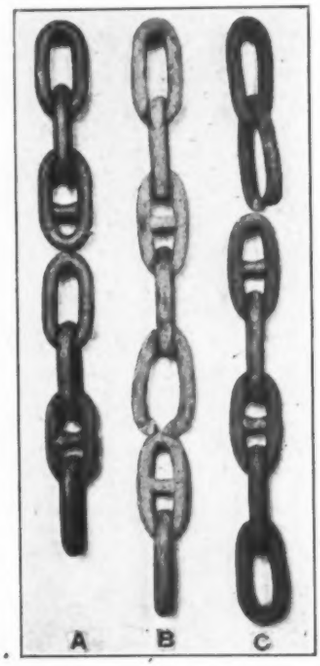


Fig. 16.—Samples of Chain after Test.

Static tensile tests made on the dredger chain in the "as received" condition showed primarily that the welded joints were in a poor state. In some cases, an extremely brittle type of fracture was obtained at a section remote from the weld. In Fig. 15 A shows such a fractured link and illustrates the extremely brittle type of fracture (occurring at the points of maximum stress for a studded link) which will be referred to as a "double-crown" fracture. The other end of the link is cracked nearly all round with a very fine crack; this is formed after the main fracture has occurred by bending actions tending to open the link, thus putting the inside of the crown of the unfractured end in a state of *tensile* strain. Although the amount of this strain must have been small, the inside of the crown has not deformed plastically but cracked in a very brittle manner. Samples tested in the annealed or normalised conditions did not exhibit any such cracks but deformed in an extremely ductile manner. B shows the fractured link of an annealed sample. Great ductility is exhibited, and there is complete absence of any cracks at the unfractured end of the link. The effect of annealing or normalising was to produce greatly improved tensile properties, especially in the values of the energy absorbed to cause fracture and the total elongation; every fracture occurred at the welded crown of the link concerned. The very brittle condition of the dredger chain was brought out in the most marked manner, however, by the shock tests (impact-tensile) on chain samples. Samples tested in the "as received" condition broke with a double-crown fracture, in a very consistent manner, absorbing very little energy, while the links, as a whole, suffered very little deformation. Annealing or normalising removed this brittleness, and the fracture of such heat-treated samples always occurred at a welded joint. Examination showed that these welds were in a defective condition; many were gaping widely at the centre of the link section, and had undoubtedly suffered marked deterioration under service shocks and snatches. The appearance of typical samples after test will be seen from Fig. 16, which shows three samples, all broken under shock. These samples, A, B, and C, were tested in the "as received," annealed, and normalised conditions respectively. Typical results of the static tensile and impact-tensile tests on chain samples (each consisting of seven links) are given in Table III. These tests show conclusively that the chain is in a highly brittle state, although *specimens cut from the interior of the links* exhibit great ductility and shock-resisting properties. An annealing or normalising treatment restores the chain to a state of great ductility and very greatly increased resistance to shock; in fact, save for the condition of the welds which have deteriorated in service, an annealed or normalised sample is but little inferior to one taken from new chain. These facts led to the very definite conclusion *that the brittleness present must be confined largely to the surface of the links particularly in the neighbourhood of the crowns of the link.* A large number of the remaining links of the dredger chain were examined carefully in order to find out if cracks were present. None was found, but the inside of the crowns of the links presented a black, highly polished appearance. This would normally be taken as evidence of wear, but measurements of the diameters of the link crowns failed to show any marked reduction in comparison with the remainder of the links.

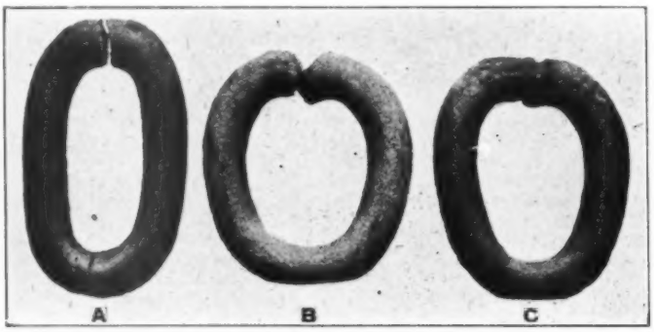


Fig. 17.—Links of Dredger Chain after Fracture.

In chain-making shops and chain-repairing establishments, the workmanship in a chain is often tested by placing individual links end-up on an anvil and striking the crown of the link with repeated blows, using a sledge hammer. In new links of sound iron and correct welding, considerable deformation should occur before fracture. This test, made on a great number of links of the CER and CES chains, afforded very useful information regarding the degree and location of the brittleness present; in particular, the course of the crack could be studied during successive impacts. A brief summary of the results is given in Table IV.

Fig. 17 shows the appearance of typical links of the dredger chain after fracture by the hammer

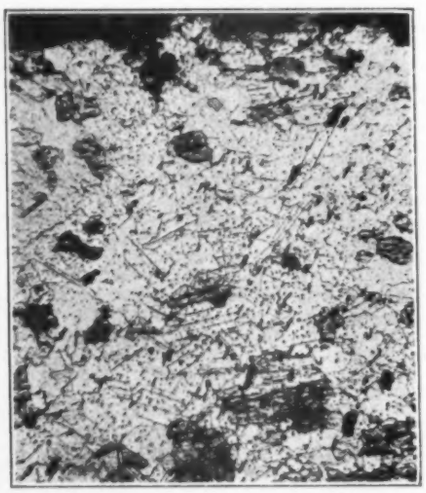


Fig. 18.—Structure of a Specimen taken from the Crown of a Link. × 40 dia.

Fig. 19.—Before Annealing. × 170 dia.

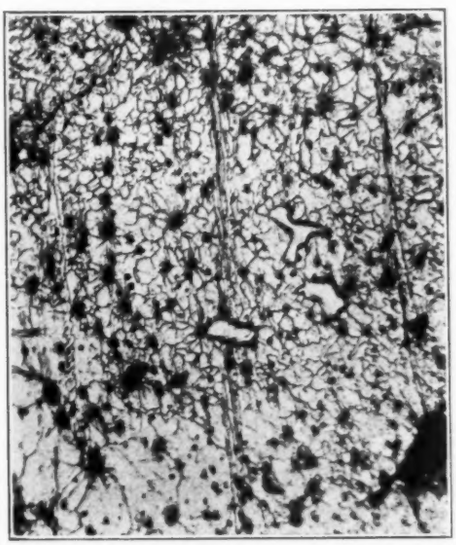


Fig. 20.—After Annealing. × 170 dia.

test, A, B, and C being samples tested in the "as received," annealed, and normalised conditions respectively. In the tests made in the "as received" condition, it was found that once a crack started, it quickly spread round the surface of the section and not through the section, indicating that this path was determined by a brittle surface rather than a brittle section. The appearance of each fracture was coarsely crystalline throughout with no visual indication of a defective outer skin. This entirely rejects the possibility that the cause of brittleness was *bending* strain, and as stated previously, the links themselves were not in a deformed state when received. As a cause of the brittleness present, severe static straining could now be definitely discarded, in view of all the above evidence, and the conclusion was formed that the cause of brittleness was an impact-hardening of the surface of the link due to interlink action, battering on chain-wheels, and other shocks encountered in service. Further, it appeared certain that the depth to which this impact hardening had pentrated was very small. A study of the microstructure of specimens cut from the crowns of links of the dredger chain, and of the effect of annealing and normalising upon the microstructure furnished evidence entirely consistent with the mechanical test results. Fig. 18 shows the structure of a specimen taken from the crown of a link in the condition as received. It will be noticed that the crystals close to the edge of the section do not show sign of any marked distortion. Neumann lamellæ are present in large numbers, indicating that the metal has been subjected to shock. These lamellæ commence close to the surface of the link and are present to a depth of 0.05 to 0.10 in. Fig. 19 shows a similar sample at a higher magnification (170 diameters), while Fig. 20 shows the same field as Fig. 19 after annealing. Profuse recrystallisation has occurred, resulting in a very finely divided structure. The maximum depth to which refinement extended, on a number of specimens, was found never to exceed 0.01 in. Thus, it is evident that the restoration of ductility conferred by low-temperature annealing or normalising on an impact-hardened chain is due to this recrystallisation of a very thin surface layer.

TABLE III.—*Static Tensile and Impact Tests on Chain Samples.*

Chain.	Condition.	Static tensile tests.			Impact tensile tests.		
		Yield load. Tons.	Max. load. Tons.	Extension at fracture (measured on 4 links).	Total energy absorbed to cause fracture. Ft.-tons.	Average extension of unbroken links per link. Inches.	Type of fracture.
Old dredger chain (CER)	As received	18.0*	26.5	0.89	2.48	0.04	Double crown.
	Annealed	12.0	26.3	1.86	11.45	0.49	Welded crown.
	Normalised	10.0	26.3	2.30	13.97	0.62	,, ,,
New chain (CES)	As received	19.0*	30.9	2.07	11.14	0.41	,, ,,

* Note that the proof load for 1-in. studded cable is 18 tons (Anchors and Chain Cables Act, 1899).

TABLE IV.—*Hammer Tests on Chain Links.*

Chain.	Condition.	Number of blows to fracture.		Type of fracture.
		Limit values.	Average for series.	
Dredger chain (CER)	As received	1 to 23	12	Coarsely crystalline, short and sharp, no appreciable distortion of link.
	Annealed	33 to 85	58	Mainly along scarf, great distortion.
	Normalised	52 to 154	84	Do.
New chain (CES)	As received	48 to 303	174	At welded crown.
	Annealed	130 to 220	178	At welded crown or along scarf.
	Normalised	175 to 215	195	Mainly along scarf.

Experiments Showing that the Brittleness and Characteristics acquired by Wrought-Iron Chains in Service can be produced in New Chain Links and Chain Iron by Repeated Small Impacts.

It was recognised that to demonstrate satisfactorily that brittleness in chains is caused by surface impacts of such a character that the link as a whole is not deformed, it was essential to produce such brittleness on new chain links and chain iron, and experiments were made on these lines.

(i) *Tests on Chain Iron.*—A number of bars of best quality chain iron (Reference Mark CRK), 1 in. diameter and 6½ in. long were used. They were lightly hammered, using the flat end of a 2-lb. riveting hammer, over the complete circumference for a length of 3½ in. symmetrically placed with regard to the middle of the bar. One thousand light blows were given to each bar, each square inch of surface thus receiving approximately 90 blows. The blows were so light that the bar, as a whole, was not appreciably deformed, the surface merely showing signs of small local depressions. The specimens were tested under bending impact, resting on the bed of the anvil of the machine and supported at each end by hammer faces on the anvil, while the centre of the specimen was struck by the striker of the swinging hammer of the machine. A constant striking velocity and energy were used throughout. Some bars were tested as received, others after annealing or normalising (for comparative purposes). Hammered bars were tested (*a*) as hammered, (*b*) hammered, then annealed, and (*c*) hammered, then normalised. Other bars were hammered, the surface being then removed by machining down to ⅞-in. diameter and subsequently tested; comparative tests were also made on new specimens (unhammered) turned down to ⅞-in. diameter. A summary of the test results appears in Table V. Fig. 21 shows the appearance of typical specimens after test. Specimen D is typical of the appearance of a bar after the hammering treatment.

The results of the tests are quite definite. Light surface hammering produces definite brittleness, which is completely removed by a subsequent annealing or normalising treatment. Further, the fact that a hammered bar from which the deformed surface has been removed, behaves in an entirely ductile manner, shows that the brittleness originates in the surface material.

(ii) *Tests on Chain Links.*—Attempts were then made to produce a state of brittleness in new chain links by a series of light surface impacts, and to observe the effect of heat-treatment upon such hammered links. In order to make the results comparable with those already obtained from the very brittle dredger chain (CER) drawn from service, links of a new 1-inch studded chain (CES) were used. In the dredger chain, the maximum hardening effect was found to be present at the *inside* of the crown of the link; owing to the presence of the stud in the links it was difficult to apply hammer blows at this exact point of the new links. However, the results show that the treatment applied has been sufficiently successful to prove the point at issue.

A 2-lb. and a 1-lb. hammer were used, and a succession of *light* blows was given to every por-

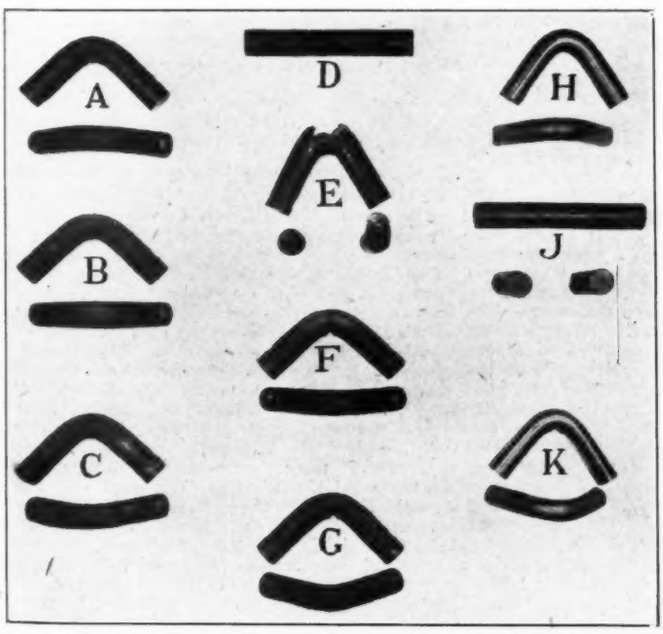


FIG. 21.—IMPACT BENDING TESTS ON BARS OF CHAIN IRON.

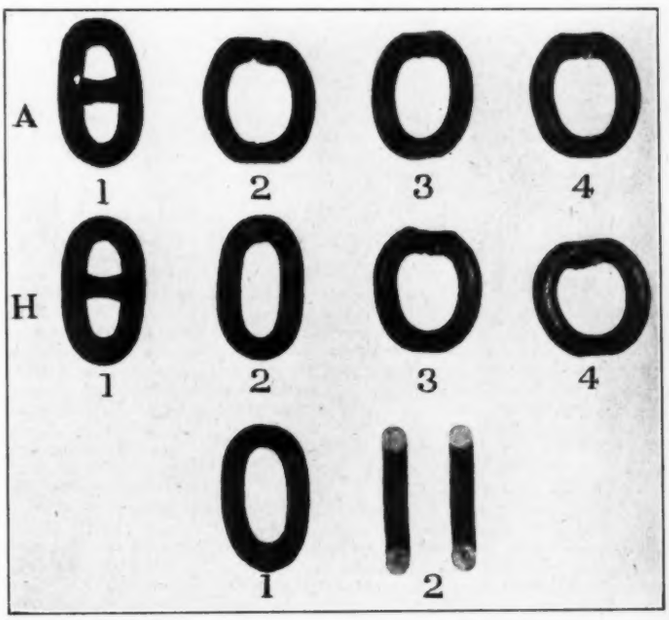


FIG. 22.—TYPICAL FRACTURED LINKS.

tion of the link except in the neighbourhood of the stud. As the result of trial experiments it was found that 500 blows with the flat of the 2-lb. hammer applied to outside surfaces, and 700 blows with the ball end of the 1-lb. hammer applied to inside surfaces, produced an approximately uniform degree of local deformation over the complete link and these numbers were used throughout.

The hammer test, previously described in connection with the tests on the dredger chain (see Table IV), was again employed. To secure uniformity of blow, all the tests were made by the same operator. A summary of the results is given in Table VI.

Photographs of typical fractured links are shown in Fig. 22. A1 shows a new link, while H1 shows a link after receiving the surface impact treatment; it is undeformed in shape. H2 shows exactly the same features as those revealed in links of the dredger chain tested in the same manner; the important features are the brittle type of failure and the fine crack on the inner edge of the crown. Annealing or normalising restores the original ductility of the iron as in the case of the dredger chain links. Finally, the microstructure of links subjected to impact shows exactly the same features as those observed in the sections of the dredger-chain links, while annealing produces the same recrystallisation phenomena resulting in a great refinement of structure.

It has thus been demonstrated that by the application of light surface impacts new chain links and new chain iron can be made to exhibit the brittle characteristics of wrought-iron chains drawn from service in such a precise manner as to leave little doubt that the brittleness in each case arises from the same common cause.

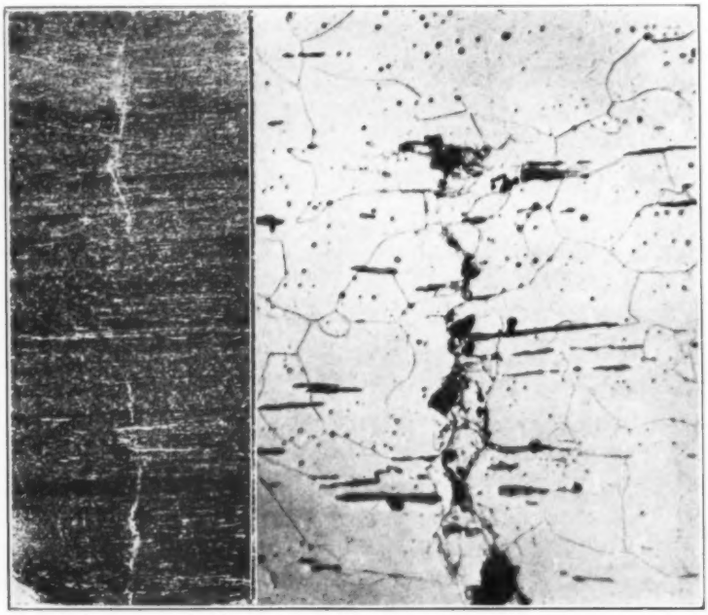


Fig. 23. × 4 dia.

Fig. 24. × 200 dia.

Table V.—*Results of Impact Bending Tests on Bars of Chain Iron.*

Reference letter in Fig. 21.	Previous treatment of samples.		Energy absorbed (average) ft.-lbs.	Remarks.
A	None.	1 in. diameter	2,020	Bent through 90 deg.; not cracked.
B	Annealed.	1 in. diameter	1,640	do. do.
C	Normalised.	1 in. diameter	1,630	do. do.
E	Hammered.	1 in. diameter	1,673	Completely severed.
F	Hammered, then annealed.	1 in. diameter	1,860	Bent through 83 deg.; not cracked.
G	Hammered, then normalised.	1 in. diameter	1,630	Bent through 89 deg.; not cracked.
H	Hammered, surface then removed by machining. ¾-in. diameter.		1,760	Bent through 110 deg.; not cracked; extremely ductile.
	None; turned to ¾-in. diameter.		1,590	Bent through 111 deg.; not cracked; extremely ductile.

Experiments showing that a Brittle Case covering a very Ductile Core will make the Whole Section behave in a very Brittle Manner under Shock Conditions.

It may be argued that given the existence of a thin impact-hardened skin on the surface of a chain link, no evidence has yet been advanced to show that a crack started in the hardened surface skin will be propagated through the link section if the remaining material is in an essentially ductile state. Purely mathematical considerations would predict that failure would occur exactly in this manner, and would further demand that fracture across such a link would take the form of a very fine crack or cracks unaccompanied by any marked distortion of the crystals through which the crack passed. Fig. 23 shows that the latter prediction is verified. It shows a section through the crown of one of the dredger-chain links. This particular link had been placed end-up in a blacksmith's anvil and had received one light blow with a sledge hammer. As a result it cracked at the crown, the course of the crack being first round the surface of the link and then inwards towards the centre, the section not being entirely severed. Fig. 24 shows the end of one of these cracks at a higher magnification. The general characteristics of the crack in all respects conform to those predicted above. Although mechanical tests (see Table II) had failed to show that any abnormality was displayed by the core of the links, yet it might still be argued that the propagation of a brittle form of crack across this core *might* be rendered possible by some defect caused by shocks and strains received in service by this chain. To remove this last possibility in an effective manner, it was decided to reproduce the chain failure phenomena in chain links and chain iron which, although covered with a brittle case, contained a core which had never been subjected to any shocks or static straining. The production of the case by surface impacts—as in the previous case—would not meet these required conditions, but case-hardening by carburisation offered an excellent means of demonstrating the point at issue.

A number of new links from the CES chain, also some specimens of new chain iron (1 in. diameter by 6½ in. long) were case-hardened.* The hammer test was then applied to the links. All behaved in an extremely brittle manner. The average number of blows to fracture was *six* only. Each fractured through the crown in an extremely "short" manner. The appearance of the face of the fracture was brittle *throughout*, the coarsely crystalline appearance of the core being precisely similar to that of the links of the old dredger chain when tested in the condition as received. In Fig. 22 the bottom row shows fractures of the case-hardened links. No. 1 shows that the link as a whole is not deformed (compare this with H2), while No. 2 gives a good idea of the brittle appearance of the core.

Table VI.—*Results of Hammer Tests on New Chain Links.*

Reference marks in Fig. 22.	Previous treatment.	Number of blows to produce complete fracture at one end.		Type of fracture and location.
		Limit values.	Average.	
A2	None (as received)	48 to 517	172	At welded crown or along scarf.
A3	Annealed	130 to 220 (unbroken)	178+	Do.
A4	Normalised	175 to 200 (unbroken)	195+	Do.
H2	After surface impacts.	5 to 30	13	Short and sharp at crown; no appreciable distortion; coarsely crystalline fracture.
H3	Surface impacts, then annealed.	60 to 209	133	At welded crown or along scarf.
H4	Surface impacts, then normalised.	81 to 200 (unbroken)	179+	Mainly along scarf.

The tests on the case-hardened bars of chain iron are even more convincing. These bars were tested under bending impact. They behaved in an extremely brittle manner throughout, the average value of the energy absorbed being 470 ft.-lbs. They broke across without any appreciable deformation of the bar as a whole, the fractured surfaces being in all respects similar to those of the case-hardened chain links. To show that the core of these bars was essentially ductile, a series of tests was made on case-hardened bars after the case had been ground off, the diameter thus being reduced from 1 in. to ¾-in. Under test, these bars were extremely ductile; they bent through a considerable angle (110 deg.) without cracking, while absorbing an average energy of 1,690 ft.-lbs. Fig. 21, J, shows a case-hardened bar after fracture, while K refers to a bar from which the case has been removed by grinding prior to the test.

These tests appear to be conclusive and to complete the establishment of the chief cause of the brittle failure of chains in service.

Conclusions Drawn from the Results of the Research.

Excluding failures due to such obvious causes as gross overloading (statical or snatch), defective chemical composition or bad workmanship in manufacture, which are easily identified, the research has shown that the failure of wrought-iron chain and cable may be caused by one or more of three main types of defect. In the first case, a brittle state may be set up as a result of overheating or burning of the chain iron during one of the stages of manufacture, or of the chain link during the forging process. Second, it has been shown that service shocks and strains tend to bring about a progressive deterioration of the weld, and this deterioration may be of such a nature that the defect cannot be detected either by the usual method of test (proving) or by visual examination of the chain. Heat-treatment cannot cure either of these two types of defect. The third and most important cause of brittleness is associated with the type of service demanded of chain and cable. As a consequence of inter-link action, hammering

* Carburising mixture: 60 per cent. wood charcoal; 40 per cent. $BaCO_3$. Treatment: heat for 2 hours in mixture at 930 deg. C.; water-quench from 870 deg. C.

on the ground, snatch-loading, rattling through hawse pipes, battering on chain wheels, cleaning by rumbling machines, and similar actions to which chain-cable may be subjected, the material of the surface of the link, in some cases to a very small depth only, becomes locally hardened to such a degree that its ductility is practically exhausted. The link section then consists of a thin, highly brittle case covering a core which may possess the ductile properties of best chain iron. When the link section is subjected to bending strains, particularly those caused by shock conditions, the hardened skin strains elastically and then cracks. This crack is of such a shape that very great stress concentration occurs at its root. When the crack reaches the underlying ductile material, the latter cannot exert its property of ductility because of the prevailing conditions of local constraint. The crack then continues its course throughout the section of the link, producing a fracture which has an entirely brittle (apparently coarsely-crystalline) appearance throughout. Recrystallisation proceeds readily at 650 deg. C. in this hardened surface layer. Hence, heat-treatment, either annealing at a dull red heat, or normalising at 1,000 deg. C., will effectively restore the chain to a condition of great ductility by effecting recrystallisation of the hardened surface layers of the chain links. Such heat-treatment must therefore be regarded only as a *cure* for surface embrittlement; it is not a means of prevention of the subsequent redevelopment of brittleness in service. One of the main results of the present research is, therefore, to endorse the present practice of periodical low-temperature annealing of wrought-iron chain and cable, and to place the employment of that practice on a rational basis.

APPENDIX.

Chemical Analyses.

Chemical analyses have been made of the chain links and chain iron used in the research; the results obtained are as follows:—

Distinguishing mark of chain or chain iron.	Content, per cent.				
	C.	Si.	S.	P.	Mn.
CER ..	0.01	0.15	0.022	0.32	0.08
CEN ..	0.01	0.15	0.016	0.37	0.08
CEQ ..	0.03	0.16	0.014	0.22	0.05
CET ..	0.01	0.11	0.023	0,24	0.08
CSJ ..	0.02	0.12	0.022	0.28	0.08
CES ..	0.03	0.14	0.022	0.26	0.09
CRK ..	0.01	0.11	0.018	0.27	0.11
RUX ..	0.02	0.13	0.022	0.31	0.06

Research Problems in the Non-Ferrous Industry.

The eighth Annual Report of British Non-Ferrous Metals Research Association was held on May 11 at the Grand Hotel, Birmingham, Mr. Thomas Bolton presiding. Amongst those present were Sir Henry Fowler, Mr. Gilbert Vyle, Prof. Hanson, Prof. Tavernor, Mr. H. W. Clarke (James Booth & Company, Limited, Dr. H. Moore (Woolwich Research Department), Dr. L. Aitchison, Mr. H. C. Dews, Mr. J. G Pearce (Director, B.C.I.R.A.), Mr. V. C. Faulkner (Editor of The Foundry Trade Journal), and Dr. R. S. Hutton (Director, B.N.F.M.R.A.).

The report showed that expenditure on research in 1927 amounted to £20,476, as against £609 in 1920. There were 144 subscribing members, and the subscriptions amounted to £10,064. The outstanding feature of the past year had been the founding of an industrial applications and development section. Until recently, the report explained, their organisation had been planned in the belief that members would seize and themselves apply any new scientific information available to them from the Association's researches. The main work had, therefore, been concentrated on the productive side of their researches. But more recent experience had shown that the task of a research Association in such industries as theirs often only commenced when research reports were available.

Those reports needed interpretation, and the new scientific information contained in them required to be brought home to a highly complex industrial organisation not always in a position to accept or apply it without a great deal of further assistance. This was not a startling revelation so far as the more abstruse scientific work was concerned, for although this country had always held an advanced position in metallurgical research of a scientific character, it was fairly generally recognised that its scientific discoveries had been more readily applied to industrial objectives by some of our foreign competitors. It was to tackle these problems that the new "Development Section" had been established, and it was hoped to mobilise a suitable staff for the prime object of fostering, in close collaboration with the researchers, the application by members of the results of the Association's own work and of scientific research carried out elsewhere.

Provision Against Obsolescence.

The habit of specifically devoting funds to research was quite modern. The custom of making provision for depreciation and obsolescence of the annual accounts of an industrial concern on the other hand must be very old, and, like many similar customs, had in many cases lost its original meaning. If industry could be brought to see that depreciation and obsolescence were in most cases caused much more by the advance and progress of competitive materials and processes than by spontaneous decay, the items "depreciation" and "obsolescence" would, on the opposite side of the accounts, be largely balanced by "research expenditure," "development work," etc.

Government Terms Revised.

Many industrial units to-day financed research enterprise as though it were a small charitable organisation far removed from their own sphere of interest; others only paid contributions equivalent to that of a low-grade employee, whilst only in rare cases did they find companies themselves spending adequate sums on research and development and at the same time giving generous support to outside co-operative research developments. Not only could research serve as a provision against obsolescence, but the research monopolised by others could directly cause a more rapid depreciation and decay of one's own enterprise. The Department of Scientific and Industrial Research had shown its confidence in the Association by a most generous revision of the terms of grant for the years 1927, 1928, and 1929, conditional on greater efforts being made to strengthen the Association's position. The Department had undertaken to pay a block grant of £5,600 a year for 1927, 1928, and 1929, provided the approved income of the Association from the industry reached a minimum of £8,400 in each of those years.

Co-operation with Labour Sought.

The Chairman, at the luncheon which followed, said their research work was the linking together of science and industry much to the advantage of industry. Industry for many years past had of necessity been in a state of transition from the tradition of arts and crafts to that of applied science, and research was a means of accelerating the transition. We were not behind other countries in the knowledge of our scientists, nor in the skill of our workers, but, in the combination of the two, he would not like to say we were more than abreast. What we were trying to do to-day was to compete in the markets of the world, and, at the same time, maintain a higher standard of living than was to be found in any of the countries we were competing with. He did not think we had had all the help we might have had from that section of the workers commonly called Labour. There might have been a tendency to insist rather strongly on the improvement of the standard of living without sufficient recognition of the need for individual effort and co-operation which alone could make a higher standard possible. He had heard it said this was the aftermath of the war, but he did not think the war had anything to do with it. It was simply the result of improved education, and for that reason they need not view it with any apprehension. They might safely take such a manifestation to be a passing phase. They had a generation of men who were better educated than their fathers, and not unnaturally they had an ambition for a better standard of living—an ambition so strong, as to become an obsession to the temporary obscuring of other ideas. But already there were signs that, as the result of education, all classes of workers would pull together and vie with one another to achieve the maximum of efficiency. There was no kind of work which could not be better done by better educated men. Labour-saving appliances might be admirable and economical, but he had never been much struck by the distinction of a machine as being "fool-proof." He did not want fools to work his machinery. The more they gave the opportunity to any of their workers to use their brains, the more interest would they take in their work and the more spontaneous would be their efforts to be efficient.

He suggested there was a parallel to be drawn in the work of their Research Association. Might it not be that some of them were a little dazzled by the glamour of the word "research," and looked for the higher standard of production without realising the necessity for the maximum of personal effort. There were in the industry quite a number of "users" who stood to benefit more than anyone else but showed no disposition to take any active share at all in the work of the Association. They preferred, so to speak, to "go on the dole." (Laughter.) The Association, within the next year, would have to become self-supporting, which would require a considerably increased income. They had taken their financial troubles to the Department of Scientific and Industrial Research, who had treated them generously.

They had stabilised the Department's grant for the remainder of the quinquennial period. This had been done, as Mr. H. T. Tizard, secretary of the Department, had written, "in the hope and faith that the encouragement given by the State would be an incentive to the industry to do likewise." Concluding, the chairman hoped it would be possible to extend the Central Laboratory, making room for offices and a research bureau.

Evaluating Obsolescence.

Mr. Gilbert C. Vyle said it was true that in an ordinary balance-sheet they would find a certain fund put down for depreciation and obsolescence of plant and machinery, tools and patterns. But they never saw anything put down for obsolescence of knowledge, and of processes in the use of material. He thought it was a happy suggestion in their report that something should be done to evaluate what such inefficiency meant in figures on the balance-sheet. Industry would never keep pace with the procession unless they put men on one side to do advanced thinking, discovery and development.

Prof. D. Hanson said a recent visit to America had shown him that research had developed enormously there during the last ten years, and had produced some of the most valuable contributions to fundamental metallurgical science that had been obtained during the whole history of that science. The point was that the research was being financed wholly by industrial concerns. The biggest problem to be faced was the putting of research into practice. It was most important that they should believe in research, and, again, science must be brought into the organisation at all stages. The only way to do that was to place the operations of the factories largely in the hands of men capable of understanding scientific advances and methods. That was what was being done in America.

Defective Continental Rails in South Africa.—A remarkable report has been published regarding the experience of South African railways in the recent purchase of rails from Continental makers. It is stated that orders were placed with a Belgian firm for rails for 250 miles of track, and that on delivery they were found to be largely defective. After protracted negotiations, the Belgian firm are reported to have agreed to replace free of charge 18 miles of rails, valued at £14,500, and also to replace any breakages within the next six years, against which they have lodged £10,000 as security. Expert investigations into the cracking of rails of several other nationalities in the Natal electrified section, have shown that they are unable to stand locomotive strains on the curves, and suffer from the action of electrolysis. It is noteworthy that apparently no British rails were involved.

Some Furnace Problems.

By A. J. Smith.

How Far Can the Furnace Designer be Expected to be an Expert in Every Trade?

The supply of plant for any heating process in a modern works or foundry occasionally gives rise to some interesting problems as to the apportionment of responsibility in the design of furnaces and similar plant. It is generally assumed that the furnace designer, in addition to being an authority upon all points of furnace construction, is also no less an expert upon the special requirements and the manufacturing processes of the trade for which a furnace may be supplied. It is an assumption which is very flattering to the designer, but it is occasionally apt to lead to consequence from which a more modest view of his responsibilities and duties would have saved him.

Combination.

The truth is that the most successful furnace installations have generally been the result of full co-operation between the user of the plant and the designer. The former should in all case be prepared to specify fully and without reservations the requirements which have to be met, and he would then have a greater likelihood of obtaining apparatus which would give the most complete satisfaction. At the present time it is unfortunately a fact that an engineer often seems to lose his sense of perspective when putting out an inquiry for anything in the way of furnace equipment, and to assume that in the furnace manufacturer he is dealing with an organisation which possesses not only an expert's knowledge of the requirements of every industry under the sun, but also to a very considerable extent the gift of second sight!

The result of the vague manner in which furnace requirements are outlined have an adverse effect both upon the furnace constructor and the user. The former, through lack of certain data, occasionally tackles an installation for which his design of furnace is not altogether suitable, but in other cases it may be that the user pays a fancy price for a complicated design where a much simpler standard plant would have served equally well, as effective competition is often eliminated by the producers of the simpler standard plant, fearing to put forward their regular design from lack of exact data of the requirements, and suspecting the possibility of undue trouble where none exists.

Examples.

As examples of the trouble which is apt to arise from an incomplete statement of the user's practice might be mentioned the case of a foundry where a furnace was required capable of melting a given quantity of metal in eight hours, but owing to no mention being made of the important fact that the moulds into which the metal had to be run were extremely small, the pouring time necessarily exceeded the melting time, and as a consequence a well-designed furnace failed to meet requirements in the way of output. Somewhat analogous is the case of the works requiring an oven furnace capable of annealing a given weight of metal over a stated period, where no mention is made of the fact that the practice in that particular works is to prolong the duration of the annealing process considerably longer than normal, and as a consequence the plant may also fail to meet the requirements of the buyer, largely through neglect on his part to specify the working conditions.

Contrast.

By way of contrast to the vague inquiry which assumes that the furnace manufacturer is as intimately acquainted with the special requirements as the client himself, one may occasionally come across furnace inquiries which seem to err in the opposite direction. In one such instance where a battery of a dozen melting furnaces, was required, the buyer went so far as to specify, roughly, the internal shape and size of furnace required, which had to accommodate a special size and shape of crucible, referred to as one of "200 lb. capacity." A further stipulation was that the price quoted must be competitive with the prices of other makers of this particular size of furnace. It is perhaps needless to add that the quotation put forward was competitive through the fact of being based upon the selling prices of other makers rather than to any elaborate costing and estimating.

Although it was discovered during the course of construction that the contract looked like turning out a most unprofitable one, the exact reason was not known even after inquiries made of different crucible makers had elicited the fact that none of them appeared to be acquainted with any special crucible of the capacity in question. It was finally discovered almost by accident that this special shape of crucible was really one of 400-lb. capacity, so that the price quoted had been based upon current prices for apparatus exactly half the capacity of what was being supplied. The possibility that such a course would be followed, and that such a price would be quoted may, of course, also have occurred to the user when deciding to send out his inquiry in this manner!

The Responsibility.

The question of the success of an installation often narrows itself down to the issue of what should be the responsibility of the furnace designer for the plant he produces or quotes for. That he should be responsible for temperature, for output, and for coal consumption goes without saying, but this responsibility should be conditional upon a full disclosure being given of the individual practice of the user which might tend to modify any calculations under these heads. In this respect, the position of the furnace designer should really coincide with that of an architect in the design of a factory or other building. Though the latter is responsible for the plans, it is hardly to be supposed that the client would ever get the fullest satisfaction from the resulting erection if he failed to co-operate by explaining fully his individual needs, and it is to be feared that many unfortunate experiences with industrial furnace plant are to be attributed mainly to the assumption that the furnace designer is intimately acquainted with the practice of all trades, and a reluctance on his own part to do anything to modify this view by attempting the cross-examination of a client upon his individual practice.

"Titanite."

We have received from the Constructional Engineering Company, Limited, of Titan Works, Charles Henry Street, Birmingham, an ash-tray made of "Titanite," a material they market for the production of pattern plates. The design has been cleverly thought out, and imitates the conditions expected to be found in normal pattern-plate production. In appearance, "Titanite" strongly resembles polished dolomitic limestone. As a sand-casting it is as near perfection as can be expected. The edges are beautifully sharp, whilst the lettering is very clearly reproduced. In the accompanying leaflets, the *modus operandi* is shewn to be simple yet definite, and the interesting fact that alterations can be effected. We understand that a large though limited supply of these ash trays is available for distribution to the trade, and applications will be dealt with in strict rotation, except that a reservation will be made for overseas founders.

New Companies.

Bolling & Lowe (Overseas), Limited, 2, Laurence Pountney Hill, E.C.4.—Capital £1,000. Iron brokers, etc. Directors: A. M. Doughty and G. C. Gardner.

C. S. Cadel & Company, Limited.—Capital £7,000 in 4,000 £1 8 per cent. cumulative participating preference and 12,000 5s. ordinary shares. Steel and metal merchants, etc., at 47, Victoria Street, London, S.W. Directors: C. S. Cadel and J. Burton.

Kirchner & Company (London), Limited.—Capital £1,000. Ironfounders, etc. Solicitors: Buckeridge & Braune, 3-4, Clements Inn, Strand, London, W.C.2.

D. & H. Owen, Limited.—Capital £1,000. Ironfounders at Vulcan Foundry, Atherton, Lancs.

Valentin, Limited, 3, Marble Arch, London, W.1.—Capital £10,000. Ferrous and non-ferrous metal manufacturers, etc. Directors: W. J. Valentin and E. B. Morgan.

Electric Furnace Developments.

It is pleasing to report the revival of the electric furnace industry, of which Britain has been the leading designing and constructing country since 1912.

Recent contracts received by the Electric Furnace Company, Limited, of 17, Victoria Street, London, S.W.1, indicate the very wide field over which electric heating is now being applied and the large area through which the work of British engineers and metallurgists is appreciated.

This company report that they have recently obtained a contract to supply an Ajax-Northrup high-frequency furnace for melting one ton of steel per hour from leading French steel makers, who are already using a smaller unit of this remarkable melting equipment. This installation is of four times larger capacity than any high-frequency furnace yet constructed by this or any other company. The whole of the machinery will be of British manufacture, and the furnace will be of 650 kilowatts capacity.

Other important contracts recently concluded are for several Ajax-Wyatt furnaces for brass melting for France, including an installation for the well-known Renault motor works, and batteries of six and five Ajax-Wyatt furnaces respectively have just been put into operation in the same country.

In England during the last few months contracts have been undertaken for Ajax-Northrup high-frequency furnaces for Birmingham, Sheffield, London and Braintree, while repeat orders for Ajax-Wyatt furnaces have been received from Birmingham brass manufacturers.

A pair of furnaces of 240-kw. capacity for the heat treatment of aluminium alloys have just been completed in Coventry, and are working with lower power consumption and more accurate temperature control than was anticipated. Several additional contracts have been received for furnaces varying from 40 to 100 kw. for enamelling and heat treatment of steel.

The Electric Furnace Company are also constructing a double tunnel continuous furnace with regenerative features over 100 ft. in length, in the Pottery district, for the heating of ceramic goods under the accurate control which is only possible with electric heat.

Orders for ten electrically-heated core ovens have also been received from British and Colonial Government Departments, having an aggregate load of 280 kilowatts.

The company have 45 furnaces now in construction for delivery in England, Scotland, France, Germany, Spain, New Zealand, and other countries.

Patent Specifications.

The following list of Patent Specifications Accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

29,539. Stern, M. Process of obtaining nickel or ferro-nickel. (April 7, 1926.) 269,133.

681. Traut, R. Rolling-mill having inclined work-in-rolls. (May 25, 1927.) 287,835.

4,925. Harris, H. Treatment of impure metals or alloys. February 21, 1927. 288,004.

7,390. Reads, Limited, and Wagstaff, H. Means for transporting sheet-metal plates. March 17, 1927. 288,020.

13,786. Bischitzky, F. Separation of tin from alloys, etc. May 23, 1927. 288,049.

32,948. Wellman Seaver Rolling Mill Company, Limited, and Smith, S. Process for reducing the external diameter of metal tubes. December 30, 1926. 288,359.

507. Rowlandson, C. W. St. J., and Grist, C. J. Treatment of rails manufactured of steel or steel alloys to improve their qualities. January 7, 1927. 288,369.

19,399. Rademacher, R., and Goebel, E. Magnetic separation of minerals. (July 23, 1926.) 274,889.

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Trade Talk.

Mineral and Refractory Products, Limited, London, have been appointed agents for Robson Refractories, Limited, Darlington.

Messrs. Bolckow, Vaughan & Company, Limited, have secured an order from the Central Argentine Railway Company for 7,000 tons of 85 lb. per yard steel rails and about 430 tons of fishplates.

The East Mill of the Whitehead Iron and Steel Company's works at Tredegar is to be restarted in the first week in June. This mill has been idle since November last.

Messrs. R. Williamson & Sons are building a coastal steamer at their Workington shipyard. She is expected to be ready for launching by August. It is over twelve months since a launch was made from this yard.

During the past few months Meldrums, Limited, of Timperley, near Manchester, have received orders for their forced-draft furnaces with smoke consumers to be fitted to no fewer than 80 boilers, mainly of the Lancashire and Cornish types.

The Standing Committee appointed by the Board of Trade will hold their inquiry as to whether imported ball and roller bearings should bear an indication of origin at 11.30 a.m. on Monday, June 4. If necessary, a further meeting will be held on June 5.

The Redburn Iron and Steel Works, Scunthorpe, of Richard Thomas & Company, Limited, are to be restarted after having been completely closed down since 1924. A start will be made with a part of the coke ovens and blast-furnace plant as soon as possible.

A substantial increase in the funds of the Amalgamated Engineering Union during last year is recorded. The balances of the union's funds at the end of the year were:—General fund, £246,531; superannuation reserve fund, £1,556,035; making a total of £1,802,566.

Dr. Robert J. Anderson, director of research of the Fairmont Manufacturing Company, Fairmont, Va., U.S.A., was elected a vice-president of the company at the last meeting of the board of directors. The Fairmont Manufacturing Company produces aluminium sheet and coil.

When the French producers of ferro-silicon joined the International Syndicate a few weeks ago, practically a monopoly of this material was established, as the Syndicate control 90 per cent. of the European works. As a counter-move, an arrangement has been concluded between a number of Sheffield and other British consumers and the Bjolvefossen Works in Norway for the delivery of the whole of the latter's output of ferro-silicon, amounting to nearly 20,000 tons per annum. In an official announcement issued by the Sheffield representatives of the Syndicate it is denied that the Syndicate was formed to exploit steelworks consumers, but to consolidate a number of Scandinavian and Continental producing works with a view to securing adequate supplies to all markets at a reasonable price. From 12,000 to 15,000 tons of ferro-silicon are consumed annually in this country, of which total Sheffield works take about 25 per cent.

Steel and Safeguarding.

Views of N.F.I.S.M.

The following resolution has been passed by the executive committee of the National Federation of Iron and Steel Manufacturers and forwarded to the Chancellor of the Exchequer:—

That the National Federation of Iron and Steel Manufacturers, while acknowledging with gratitude the proposals of the Chancellor of the Exchequer with reference to the relief to be granted to industries in respect of local rates and railway rates, desires to point out the extreme urgency of the present difficulties of the iron and steel industry and to ask that these proposals may be made immediately effective and retrospective from the date of the introduction of the Budget.

Having carefully considered the practical effect of these proposals, they desire to express their considered opinion that a further and much greater measure of assistance is necessary if the iron and steel industry is to keep pace with developments in other countries, and to be in a position to compete with them both in the home and export markets, as existing conditions operate so greatly in favour of their Continental competitors and so unfairly against the British industry, especially in respect of lower wages, longer working hours, lower railway rates, devaluated currencies, and other conditions.

They therefore desire to record their opinion that some reasonable measure of safeguarding should be immediately applied to the industry, as being the only effective method of maintaining even the present standard of living of the workers engaged in the industry and preventing a further contraction of the industry, with consequent increased unemployment.

Contracts Open.

Cairo, August 14.—Construction of a metallic bridge over the Nile at Benha. Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference A.X. 6243.)

Dublin, May 30.—Iron and steel stores for six months commencing July 1, 1928, and, alternatively, for 12 months commencing same date, for the Great Southern Railways Company (Ireland). Stores Superintendent, General Stores Department, Inchicore, Dublin.

Hinckley, May 26.—Supplying and laying about 3½ miles of 10-in. weldless steel pipes, for the Urban District Council. Contract No. 1 includes for excavating, etc.; contract No. 2 includes for pipes and jointing. Mr. F. Lee, engineer and manager.

Johannesburg, June 21.—Steel tyres (1929 requirements), tender No. 1,222, for the South African Railways and Harbours. Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference A.X. 6267.)

Johannesburg, June 21.—Chains for period ending June 30, 1929, for the South African Railways and Harbours. Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference A.X. 6271.)

Johannesburg, July 5.—618 mild steel plates, 704 mild steel angles, 266 mild steel bars, 18 tons rivets, 3,540 bolts and nuts, 80 coach screws and 2,000 washers, for the South African Railways and Harbours. Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference A.X. 6293.)

Newcastle-upon-Tyne, May 24.—Iron and steel stores for six months from July 1, 1928. River Works Committee, Bewick Street, Newcastle-on-Tyne.

Company Reports.

Palmers Shipbuilding and Iron Company, Limited.—Mr. Charles F. Spencer, chairman, presided at the annual meeting in Newcastle on May 10. He regretted it had not been possible to restart the steelworks owing to the state of trade, but they were, however, running two blast furnaces, one on hematite and the other on pig-iron. These furnaces had been in blast since the end of March, 1927, and the iron produced was being disposed of at home and abroad. They were getting their full share of work placed on the North-East Coast. Dealing with the burden of rates, the chairman said at one of their works the rates paid in 1927 were 405 per cent. higher than in 1912.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Lord Southborough, the chairman, presiding at the annual meeting, in London, on May 11, said the building of the battleship "Nelson" resulted in a substantial loss, as to which discussions were taking place with certain Government Departments. The Italian situation was not yet cleared up. Also there was their serious investment in the Pearson and Knowles group of companies, which they were doing their best to nurse along in the hope of developing a satisfactory reconstruction of the group and of maintaining the interest of the company in it. Then there was still considerable work to be done in connection with the minor subsidiary companies. While they believed they now knew the extent of their difficulties as regards civil engineering, there was still a considerable amount of work to do to get this and matters of the kind finally disposed of. The works at Scotswood and at Gateshead-on-Tyne, also the Walker shipyard, were in active operation. Scotswood was being developed and new buildings, plant and equipment were being erected and installed at a cost which would approximate £250,000. Their aim was to make Scotswood one of the best and most efficient works in the country for heavy engineering. The amount of business on hand was substantial, but the year was necessarily one of adjustment, and profits must not be counted upon until their plans for development of the works and otherwise had been completed. While the shipbuilding part of the business had been affected by the very severe competition which still existed, they had had a good share of the business. The machine-tool business, hitherto carried on at Openshaw, would in future be developed in conjunction with and in the name of Craven Brothers (Manchester), Limited, in which company they were now the majority shareholders.

Harland & Wolff, Limited.—The annual meeting was held in London recently. The Rt. Hon. Lord Kylsant (the chairman) said that it was three-quarters of a century since the old-established firm of Harland & Wolff was founded. Notwithstanding the general scarcity of orders, Harland & Wolff, Limited, were able, in respect of the year 1927, for the sixth year in succession, and for the 21st year in all, to head the list of individual firms with a shipbuilding tonnage output, based on Board of Trade computation, of 94,700 gross register tons, and a marine engine production of 80,575 i.h.p. In their principal establishment—viz., at Belfast—almost all their building slips were occupied with a bigger proportion of large passenger liners, for the construction of which their organisation was more especially adapted. Among the vessels now under construction at Belfast there were seven large passenger liners in hand, consisting of a 26,000-ton motor-vessel for the Transatlantic trade, two motor passenger ships of 20,000 tons each for the South African mail service, and four passenger and refrigerated motor-vessels of 15,000 tons each for the South American trade. At their establishments on the Clyde they were building a number of vessels, including two large motor passenger liners, one of them being similar to the four 15,000-ton motorships building at Belfast for the South American trade, and the other a vessel for the South African intermediate service. Their engine works and foundries were well occupied with engines of different types. Their engineering and repair establishments at Liverpool, Southampton and London were also well employed. In common with other shipbuilding, engineering, steel, and colliery companies, they had found the burden of both taxation and local rates exceedingly heavy. The railway freights for their group of iron, steel, and coal companies amounted last year to almost £800,000, and it would be realised that a very heavy additional burden was placed upon them by the increase, in the early part of this year, of fully 6 per cent. by the railway companies. These industries had been negotiating and were hoping for a reduction in railway charges on iron, steel, and coal, and, if the proposals in the Budget were to take the place of that contemplated reduction in railway charges, they would be very disappointing to the trade, as the relief foreshadowed by the Chancellor of the Exchequer, although very helpful, was relatively small.

Obituary.

Mr. S. Briggs, principal of Messrs. S. Briggs & Company, Limited, brassfounders, Burton-on-Trent, died on May 11.

The death took place recently of Mr. William Hutchinson, of Ireton Lodge, Goldthorn Road, Wolverhampton, who, until his retirement from active business ten years ago, was one of the best-known men in the steel trade. He was born in 1840, and in 1854 entered the service of the Weardale Iron & Coal Company, of Spennymoor, of whose works he became manager in 1870. In 1884 he was appointed manager of the Spring Vale Works of the Staffordshire Steel & Ingot Iron Company, Limited, which had just been started. Mr. Hutchinson was associated with the late Sir Alfred Hickman, the late Mr. A. W. Hickman, Mr. Edward Hickman and Mr. V. E. Hickman in their development of that business, and in 1897, when the pig-iron business of Sir A. Hickman was amalgamated with the Staffordshire Steel & Ingot Iron Company, he became joint managing director with the late Mr. A. W. Hickman, of the concern carried on as Alfred Hickman, Limited, under the chairmanship of the late Sir A. Hickman. He remained a managing director until 1917, when he retired.

Reports and Dividends.

Anderston Foundry Company, Limited.—Net profit, £11,051 (against £7,894); brought in, £570; dividend of 6¼ per cent.; carried forward, £2,621.

Dorman Long & Company, Limited.—Interim dividend at rate of 6 per cent., less tax, on cumulative preference shares for half-year ended March 31.

Industrial Steels, Limited.—Net profit, £7,353; debit balance brought forward, £369; transferred to bank loan redemption fund, £5,000; carried forward, £1,985.

Tweedales & Smalley (1920), Limited.—Trading profit, £77,330, against £74,338; brought in, £74,798, against £67,909. Final dividend of 15 per cent., absorbing £33,750, leaving to be carried forward £84,629.

Iron Trade Employers' Insurance Association, Limited.—The report for 1927 states that the premium income amounted to £597,006, which, with £81,746 dividends and interest on invested funds, profit on realised investments, and £48,049, the balance brought from 1926 account, made the total receipts £726,801. The amount paid and set aside in respect of compensation and incidental expenses amounted to £469,654, and after providing £56,312 for expenses of management, directors' fees, auditors' fees, hospital donations, staff trust fund appropriation, etc., there remains a balance on revenue account of £200,835. A return of 15 per cent. on the workmen's compensation premium paid for 1927 is proposed, together with a bonus of 12½ per cent. on which income-tax has already been paid, making a total return of 27½ per cent. to the present policyholders of the association entitled thereto.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Producers of pig-iron in the Cleveland district, alike with their contemporaries in the Midlands and elsewhere, are still pursuing a waiting policy as regards the near future outlook, and though outputs at the Tees-side furnaces are fairly well absorbed by current home consumption, there is, so far, no incentive to increase makers' tonnage. At present, home consumption is still on a limited scale, and with prices at practically stabilised levels there is no inducement to place forward business from which no material advantage could be derived. On the export side a more hopeful sign is a steadily increasing inquiry from abroad for Cleveland iron, and the shipments show a slight improvement. Sales to Scotland have not further increased, but are maintained at the higher level recorded last month. The home foundries are not busy, and, being fairly well covered for present requirements, are not active buyers. Quotations remain remarkably steady at the following levels:—No. 1 Cleveland foundry iron, 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

A slight improvement in demand for East Coast hematite may be noted of late, with a little better inquiry for export, but home consumption is still restricted in tonnage, with prices unchanged at 70s. per ton for mixed numbers and 6d. per ton more for No. 1 grade. On the North-West Coast Bessemer mixed numbers remain firmly quoted at 70s. per ton at works.

LANCASHIRE.—Many of the chief consumers of foundry pig in the area covered by the local markets, owing to scarcity of orders, are still disinclined to purchase beyond immediate requirements, and very few transactions are recorded on forward delivery account. There has, however, been little easing of prices, which rule as follow: No. 3 Derbyshire is quoted at 71s. to 71s. 6d., Staffordshire No. 3 at 71s., Cleveland at 79s., and Scotch brands from 87s. 6d. to 90s. per ton, all per ton delivered local.

THE MIDLANDS.—The Black Country ironfounders are not at all satisfied with current prices, and as conditions are still very bad with them, they are not at all disposed to move from their present position, and continue to buy small supplies to cover their immediate requirements. The following are about the current quotations: Northamptonshire No. 3, 57s. to 58s. Derbyshire, 63s. to 63s. 6d., and North Stafford, 63s. to 63s. 6d. f.o.t. furnaces. No. 3 Scotch iron is offered delivered Black Country stations from 89s. to 91s., and Cleveland No. 3 and Lincolnshire No. 3 at 81s. 9d. and 72s. 6d. per ton respectively.

SCOTLAND.—The depressed condition of the Scotch pig-iron market shows no signs of alleviation, and business is confined within very narrow limits. There is no section of the foundry trade busy, and, as a result, the demand for pig-iron is very poor, with stocks accumulating at the makers' works. The price is unchanged on the basis of 70s. for No. 3 foundry f.o.t. furnaces.

Finished Iron.

Conditions in the chief markets for finished material still leave much to be desired as concerns demand, and, so far, there is no improvement in the position of crown and nut and bolt irons. Orders for this class of iron are still very difficult to get, and nothing like sufficient business is forthcoming to keep mills in continuous operation, while there is intense competition for what business there is available. Prices vary for crown quality from £9 up to £10, and nut and bolt quality from £8 15s. to £9 5s. The price of Continental No. 3 iron has appreciated along with steel, although not to the same extent. The foreign product is quoted delivered Birmingham at figures varying from £6 8s. 6d. to £6 10s., according to the nature of the specification. There is a fairly good demand for marked bars at £12 at maker's works, and outputs at South Staffordshire mills are well maintained.

Steel.

The position in the home section of the steel market has been affected to some extent by the sharp advance which took place recently in the prices of Continental steel materials, this having checked trading considerably, although there has been a certain amount of buying of small parcels. There has, however, been a fair volume of inquiry for semi-finished steel by British consumers, but not only have the quantities offered by Continental sellers been restricted, but, generally speaking, users on this side have been reluctant to pay the prices quoted. The British steelworks have benefited to some degree by the higher Continental prices, although the inquiry from the overseas markets, which are the principal buyers of British steel, has been indifferent. In the home market also, while constructional engineers have been showing more interest in the market than of late, the general demand has been poor, and, as a consequence, the steelworks are not well off for orders. In the tinplate market quotations are firm at 18s. 6d. to 18s. 9d. basis for coke tins in approved specifications, with option of lights and crosses, and 3d. basis extra for squares and odd sizes, net cash f.o.b. Wales.

Scrap.

Only a fluctuating demand can be reported in the markets for foundry scrap material, varying according to the amount of work in hand in different districts. At Middlesbrough the foundries, too, are slack, and are only buying heavy cast iron in limited quantities, no more than 62s. per ton being obtainable for ordinary quality and 66s. for machinery quality in handy pieces. In the Black Country area cast-iron scrap in large pieces and in furnace sizes remains a little quiet at about 60s., and very little business is being done in cast-iron machinery scrap for foundry purposes at 65s. In Scotland there is no change in machinery cast-iron scrap, which is very quiet; odd lots are being offered at 70s. per ton, with little or no business doing. Heavy cast-iron scrap suitable for foundries is on offer around 62s. 6d. per ton, and for steelworks cast iron around 60s. per ton. Old cast-iron railway chairs are unchanged around 67s. 6d. to 68s. 6d. per ton, with light cast iron at 58s. 6d. to 60s. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—As indicated in previous comments on the condition of the copper market, the steadily progressive tendency in warrant values has been fully maintained, and at the close last week cash dealings registered a further fairly substantial advance. The tone of the market also is generally more hopeful, and it is anticipated that the greater firmness which has now become a feature of the situation will have the effect of bringing in consumers who have been holding off in the hopes of lower prices.

Closing quotations are:—

Cash.—Thursday, £62 10s. to £62 12s. 6d.; Friday, £62 17s. 6d. to £62 18s. 9d.; Monday, £63 3s. 9d. to £63 5s.; Tuesday, £63 7s. 6d. to £63 8s. 9d.; Wednesday, £63 7s. 6d. to £63 8s. 9d.

Three Months.—Thursday, £62 15s. to £62 17s. 6d.; Friday, £63 2s. 6d. to £63 3s. 9d.; Monday, £63 7s. 6d. to £63 8s. 9d.; Tuesday, £63 11s. 3d. to £63 12s. 6d.; Wednesday, £63 10s. to £63 12s. 6d.

Tin.—In the absence of an active speculative interest or of an increase in consumptive demand, cash tin standard values have suffered a marked set-back and now reached levels lower than at any other time this month. In spite of this, however, the tone of the market is still optimistic, the general opinion being that the decline is necessarily of a temporary character. In any case, it is apparent that actual consumption is increasing far more rapidly than world production, a state of affairs which would be hardly compatible with a permanent fall in values.

Official closing prices:—

Cash.—Thursday, £230 12s. 6d. to £230 15s.; Friday, £231 15s. to £231 17s. 6d.; Monday, £229 10s. to £229 12s. 6d.; Tuesday, £227 15s. to £228; Wednesday, £228 17s. 6d. to £229.

Three Months.—Thursday, £230 2s. 6d. to £230 5s.; Friday, £230 17s. 6d. to £231 2s. 6d.; Monday, £228 15s. to £229; Tuesday, £227 2s. 6d. to £227 5s.; Wednesday, £228 7s. 6d. to £228 10s.

Spelter.—The position in the market for ordinary spelter has, so far, been little affected by the recent organisation of European producers. Values, while fairly steady, have a declining tendency. It is believed in some quarters that an agreement between the new European zinc cartel and North American producers is well within the bounds of possibility, and that such a combine would be able to raise values by £3 to £6 per ton without materially affecting consumption.

Official close:—

Ordinary.—Thursday, £26 1s. 3d.; Friday, £26; Monday, £26; Tuesday, £25 17s. 6d.; Wednesday, £25 16s. 3d.

Lead.—Movements in the market for soft foreign pig are summarised as follows by Messrs. Rudolf Wolff & Company:—"The firmer undertone has been well maintained, for although some fairly active selling of an influential character has taken place, yet all offerings have been readily absorbed, the buying having included a fair amount of 'bear' covering. Stocks are firmly held, and supplies just now are not overwhelming, so that, with a fair prospect that general trade demand, which has latterly been rather disappointing, will broaden, there is reasonable anticipation of further moderate improvement."

Closing prices:—

Soft Foreign (Prompt).—Thursday, £20 3s. 9d.; Friday, £20 5s.; Monday, £20 3s. 9d.; Tuesday, £20 3s. 9d.; Wednesday, £20 5s.

American Output of Steel and Rolled Products, 1927.

Special Statistical Bulletin No. 3 (1928) issued by the American Iron and Steel Institute, shows a large falling off in the output of steel ingots and castings in the United States last year. It reached 44,935,185 tons only (of 2,240 lbs.) as against 48,293,763 in 1926, the record year. Of last year's output 43,776,717 tons were ingots and 1,158,468 tons were castings.

As regards processes of production, the figures for last year (compared with 1926) were as follow:—Basic open-hearth steel, 37,144,268 (39,653,315) tons; acid open-hearth steel, 924,067 (1,038,664) tons; Bessemer steel, 6,191,727 (6,934,568) tons; crucible steel, 9,036 (15,493) tons; electric steel, 666,087 (651,723) tons. Last year's output of basic open-hearth steel included 2,184,674 tons of steel produced by the duplex process, that is steel partly purified in Bessemer converters and finished in basic open-hearth steel furnaces, as against 2,815,980 tons in 1926. The output of alloy steel last year was 2,266,439 (2,463,414) tons, of which 1,845,367 tons were produced in open-hearth furnaces, 74,094 tons in Bessemer converters, 3,461 tons in crucibles, and 343,517 tons in electric furnaces.

Rolled Iron and Steel.—The following figures show the total output of rolled iron and steel in tons last year (and in 1926):—Rails, 2,806,486 (3,217,649); plates and sheets, 9,627,734 (10,529,056); nail plate, 18,051 (17,337); wire rods, 2,770,271 (2,722,032); structural shapes, 3,742,445 (3,911,663); all other finished rolled products, 13,914,044 (15,098,155); total, 32,879,031 (35,495,892) tons, of which 544,344 (676,854) tons were iron and 32,334,687 (34,819,038) tons were steel.

Sheets and Plates.—The subjoined figures show in tons the output of iron and steel plates and sheets last year (and in 1926) by size and mode of manufacture:—Universal plates, including flats and bars over 6 in. wide, 1,244,549 (1,407,547); sheared plates, 2,476,261 (2,793,635); black sheets, 3,979,037 (4,237,479); black plates rolled on tin mills, including black plates for tinning, 1,927,887 (2,090,395) tons. Of the total output 7,504 (10,399) tons were iron, the rest steel.

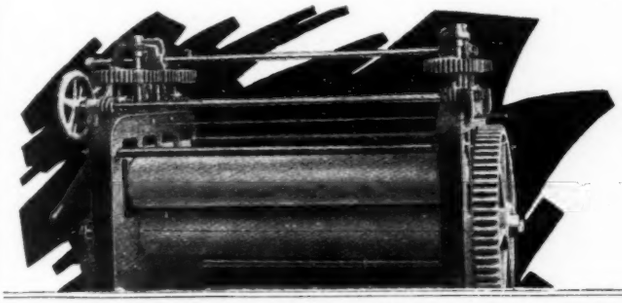
Merchant Bars, etc.—The output of merchant bars last year was 4,870,247 (5,473,836) tons and of concrete bars, 816,013 (815,829) tons.

Miscellaneous Rolled Products.—The output of these last year (and in 1926) included in tons:—Hoops, 176,300 (189,814); bands and cotton ties, 323,129 (355,926); long angle fishplates and other rail-joint shapes, 864,992 (953,563); sheet piling, 74,793 (57,189); railway sleepers, 13,826 (13,278); forging blooms, billets, etc., 285,527 (362,750); sheet bars, etc., for export, 549 (430); spike, chain, bolt, nut, etc., rods, tube blanks, tyres, etc., 3,069,816 (3,110,990); total 4,808,932 (5,043,940) tons, of which 189,590 (222,065) tons were iron, the rest steel.

Tinplates, Terneplates, etc.—Last year's output included 1,756,749 (1,875,241) net tons (2,000 lbs.) of tinplates and 117,674 (120,942) net tons of terneplates.

Pipes and Tubes.—The output of cast-iron pipes last year was 2,042,515 (2,003,506) net tons, the output of welded iron and steel tubes was 3,117,451 (3,402,515) tons of 2,240 lbs. and of seamless steel tubes 864,140 (775,329) tons of 2,240 lbs.

WHAT THE BRADLEY SERVICE MEANS TO THE FOUNDRYMAN. No. 4.



OUR EXPERIENCE AVAILABLE FOR SPECIAL CASTINGS

To those Ironfounders whose work is of a varied nature, changing from day to day, the Bradley Service is always to be obtained to give the benefit of years of experience to the solution of unusual problems.

Carefully recorded and available at any moment, Bradley's have most detailed information concerning actual mixtures that have been tried, tested and proved for specific purposes.

This information and all other assistance is part of the Bradley Service, gladly given free of charge to all who care to make use of it.

Bradley's

PIG IRON

"A QUALITY FOR EVERY REQUIREMENT"

Write or 'phone for particulars of the Bradley range of Refined Pig Irons. Immediate attention is given to all enquiries and the knowledge and long experience of Bradley's is at the disposal of all foundrymen.

Make full use of The Bradley Service

BRADLEY & FOSTER Ltd B&F DARLASTON. STAFFS.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	63 7 6
Three months	63 10 0
Electrolytic	67 15 0
Tough	65 15 0
Best selected	66 0 0
Sheets	92 0 0
India	75 5 0
Wire bars	67 17 6
Do. May	67 17 6
Do. June	67 17 6
Ingot bars	67 17 6
H.C. Wire rods	72 10 0
Off. av. cash, April	61 14 1⅛
Do. 3 mths., April	61 16 2 7/16
Do., Sttlmnt., April	61 14 0 15/16
Do., Electro, April	66 15 0
Do., B.S., April	65 0 0
Aver. spot price, copper, Apr.	61 14 1¼
Do., Wire bars, April	67 0 0
Solid drawn tubes	13d.
Brazed tubes	13d.
Wire	9⅛d.

BRASS.

Solid drawn tubes	11⅛d.
Brazed tubes	13⅛d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d

TIN.

	£ s. d.
Standard cash	228 17 6
Three months	228 7 6
English	233 5 0
Bars	234 5 0
Straits	232 5 0
Australian	230 15 0
Eastern	232 10 0
Banca	Nominal
Off. av. cash, April	234 6 0 1/16
Do., 3 mths., April	234 10 7 7/16
Do., Sttlmt., April	234 6 6 15/16
Aver. spot, April	234 6 0½

SPELTER.

	£ s. d.
Ordinary	25 16 3
Remelted	24 15 0
Hard	20 5 0
Electro 99.9	29 15 0
English	26 5 0
India	21 10 0
Zinc dust	33 0 0
Zinc ashes	8 0 0
Off. aver., April	25 8 1 7/16
Aver., spot, April	25 9 10½

LEAD.

	£ s. d.
Soft foreign ppt.	20 5 0
English	21 15 0
Off. average, April	20 8 8 1/16
Average spot, April	20 6 1⅛

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	33 15 0
Do. V.M. ex whf.	32 5 0
Rods	39 0 0
Boiler plates	29 10 0
Battery plates	31 5 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	59 10 0
Chinese	42 10 0
Crude	35 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	£8 0 0
45/50%	£13 1 0
75%	£20 10 0
Ferro-vanadium—	
35/40%	14/3 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/6 lb. Mo.
Ferro-titanium—	
23/25%, carbonless	1/2 lb.
Ferro-phosphorus, 20/25%	£19 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/3½ lb.
Tungsten metal powder—	
98/99%	1/7½ lb.
Ferro-chrome—	
2/4% car.	£32 0 0
4/6% car.	£22 2 6
6/8% car.	£21 17 6
8/10% car.	£21 10 0
Ferro-chrome—	
Max. 2% car.	£34 10 0
Max. 1% car	£39 10 0
Max. 0.70% car	£46 0 0
70%, carbonless	1/2 lb
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80%, loose	£13 10 0
76/80%, packed	£14 10 0
76/80%, export	£13 5 0
Metallic manganese—	
94/96%, carbonless	1/7 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.
South Wales—	
Hvy. steel	3 6 6
Bundled steel and shrngs.	2 19 0 to 3 3 6
Mixed iron and steel	3 0 0
Heavy cast iron	3 0 0
Good machinery for foundries	3 5 0
Cleveland—	
Heavy steel	2 17 0
Steel turnings	2 8 6
Cast iron borings	2 3 0
Heavy forge	3 10 0
Bushelled scrap	3 2 6
Cast-iron scrap	3 2 0 to 3 6 0
Lancashire—	
Cast-iron scrap	3 5 0
Hvy. wrought	3 2 6
Steel turnings	2 2 6

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	52 0 0
Brass	38 0 0
Lead (less usual draft)	18 0 0
Tea lead	15 10 0
Zinc	15 10 0
New aluminium cuttings	75 0 0
Braziery copper	47 0 0
Gunmetal	48 0 0
Hollow pewter	165 0 0
Shaped black pewter	125 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/6
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	81/-
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	71/-
,, No. 4 forge	57/6
,, No. 3 fdry.	63/-
Shrops. basic	—
,, Cold blast, ord.*	155/-
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3	57/6
Derbyshire forge	60/-
,, fdry. No. 3	63/6
,, basic	—
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	75/-
Sheffield (d/d district)—	
Derby forge	64/-
,, fdry. No. 3	66/6
Lincs. forge	66/-
,, fdry. No. 3	67/-
E.C. hematite	80/6
W.C. hematite	85/-
Lincs. (at furnaces)—	
Forge No. 4	61/6
Foundry No. 3	62/6
Basic	60/6
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	71/6
Northants foundry No. 3	—
Dalzell, (ordinary)	87/6 to 90/-
Summerlee, No. 3	87/6
Glengarnock, No. 3	87/6
Gartsherrie, No. 3	87/6
Monkland, No. 3	—
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	9 0 0 to	10 15 0
Nut and bolt iron		8 15 0
Hoops		11 10 0
Marked bars (Staffs.) f.o.t.		12 0 0
Gas strip		11 10 0
Bolts and nuts, ¾ in. × 4 in.		14 0 0
Steel—		
Ship plates		8 7 6
Boiler plts.		10 10 0
Chequer plts.		10 5 0
Angles		7 17 6
Tees		8 17 6
Joists		7 17 6
Rounds and squares, 3 in. to 5½ in.		8 17 6
Rounds under 3 in. to ⅜ in. (Untested)		7 15 0 and upwards
Flats, over 5 in. wide and up		8 7 6
Flats, 5 in. to 1½ in.		7 17 6
Rails, heavy	8 2 6 to	8 10 0
Fishplates		12 10 0
Hoops (Staffs.)		10 0 0
Black sheets, 24g.		9 12 6
Galv. cor. shts., 24g.		13 0 0
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	£6 0 0 to	6 10 0
Billets, hard	£7 2 6 to	7 12 6
Sheet bars	£5 16 3 to	5 17 6
Tin bars	£5 16 3 to	5 17 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 8½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G. with extras according to gauge.	1/6½ to 2/1½

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	17.25
No. 2 foundry, Birm.	15.50
Basic	18.26
Bessemer	19.26
Malleable	19.01
Grey forge	18.51
Ferro-mang. 80% d/d	100.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	44.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.70
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd., 9 and 10	2.00
Wire nails	2.55
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	14/- to 14/6
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/- to 13/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	18/7½
,,	28×20	,,	37/1½
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	17/-
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£17 10 0 to £18 10 0
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63½%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
May 17	62	10	0	dec. 1/3
„ 18	62	17	6	inc. 7/6
„ 21	63	3	9	„ 6/3
„ 22	63	7	6	„ 3/9
„ 23	63	7	6	No change

Electrolytic Copper.

	£	s.	d.	
May 17	67	0	0	No change
„ 18	67	10	0	inc. 10/-
„ 21	67	15	0	„ 5/-
„ 22	67	15	0	No change
„ 23	67	15	0	„ „

Standard Tin (cash).

	£	s.	d.	
May 17	230	12	6	dec. 27/6
„ 18	231	15	0	inc. 22/6
„ 21	229	10	0	dec. 45/-
„ 22	227	15	0	„ 35/-
„ 23	228	17	6	inc. 22/6

Tin (English ingots).

	£	s.	d.	
May 17	235	10	0	dec. 20/-
„ 18	236	10	0	inc. 20/-
„ 21	234	0	0	dec. 50/-
„ 22	232	5	0	„ 35/-
„ 23	233	5	0	inc. 20/-

Zinc Sheets (English).

	£	s.	d.	
May 17	33	15	0	No change
„ 18	33	15	0	„ „
„ 21	33	15	0	„ „
„ 22	33	15	0	„ „
„ 23	33	15	0	„ „

Spelter (ordinary).

	£	s.	d.	
May 17	26	1	3	dec. 3/9
„ 18	26	0	0	„ 1/3
„ 21	26	0	0	No change
„ 22	25	17	6	dec. 2/6
„ 23	25	16	3	„ 1/3

Lead (English).

	£	s.	d.	
May 17	21	15	0	No change
„ 18	21	15	0	„ „
„ 21	21	15	0	„ „
„ 22	21	15	0	„ „
„ 23	21	15	0	„ „

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS.

Year.	Jan	Feb	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	49 10½	48 8½	46 10	46 1½	48 2½
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	—	—	—	—	—	—	—	—	—

* No prices available.

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(A remittance should accompany instructions.)

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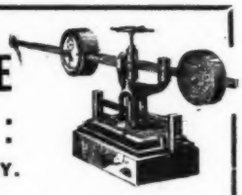

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